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ABSTRACT

The role of television in meeting the need for higher education in Iran is discussed. Topics covered in the first chapter include impact on a typical curriculum, transition characteristics, television production techniques, cost effectiveness, additional applications, and centralization or duplication. The second chapter presents a planning process for the expansion of university education using educational television, and describes a case study (Pahlavi University, Shiraz, Iran) that highlights some of the key considerations in the implementation of effective programs. Reports on educational television use in the United States and Great Britain and ETV design and production are appended, as well as degree program course listings and a computer program listing. (VT)

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THE NEED FOR HIGHER EDUCATION IN IRAN

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Bruce B. Lusignan
Behruz Rezvani
Sally Keister
Lawrence T. Brekka

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM"

December 1976

Communication Satellite Planning Center
Technical Report No. 16

Prepared under
National Iranian Radio and Television Contract
NIRT No. 1

IR005 854

RADIOSCIENCE LABORATORY
STANFORD ELECTRONICS LABORATORIES
STANFORD UNIVERSITY · STANFORD, CALIFORNIA

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COMMUNICATION SATELLITE PLANNING CENTER
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Stanford, California

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CHAPTER I
OVERVIEW

A. THE NEED FOR HIGHER EDUCATION

Higher Education is recognized by Iranian Planners as important to national economic growth. The fifth plan and the sixth plan both project major increases in college enrollments to meet high level manpower training needs. While major efforts are going into expansion of college capacities, there are limitations in resources available for building of additional classrooms and limitations in the numbers of new faculty available for the increased student enrollment. Depending on the predicted rate of growth, the economy would be able to absorb two to three times the number of students projected to be graduated by Iran's colleges and universities.

The relationship between economic growth and required university graduates has been developed by an economic sector projection program coupled with a manpower projection model. The program was developed in coordination with the Plan and Budget Organization and is summarized in Ref. 1. The annual college graduations required to meet national growth are summarized in Table I-1. Table I-2 summarizes the capacities of Iran's current institutions of higher education Ref. 2. The gap is clearly very large.

B. TELEVISION IN HIGHER EDUCATION

A number of universities in America, the British Open University and recently the Pahlavi University in Shiraz have used television courses in their curricula. Review of these applications (Appendix A) shows a wide variety of approaches and different impacts on the college systems. The experiences generally confirm, however, that most lecture-type courses can be taught effectively through television if provision is made for periodic discussion of the material with regular faculty or mentors. The course information is presented primarily through the media but in most cases, informal discussion of the material with a knowledgeable person is a necessary part of the learning process. The amount of faculty or mentor time needed for discussion varies with the application but typically is far less than the faculty time required to offer a conventional course.

Table I-1

Growth in Numbers of People Required at each Educational Level to Maintain Target Proportions

Educational Level	Number in 1972	Number in 1982	Approximate Annual Growth	Total Added	Average Annual Increase
Higher	169,337	1,038,514	19%	869,187	86,149
Secondary	1,065,658	5,097,145	17%	4,031,487	403,149
Elementary	4,052,169	8,610,267	7%	4,558,198	455,820
Illiterate	3,786,266	----	-337%	(3,786,226)	(378,627)

Source: Brekka, Lawrence T. and James Boettcher. The Role of Economic Growth and Manpower Projections in Educational Radio and Television of Iran's Planning, December 1976.

Table I-2

Graduates of Institutions of Higher Education

Institution	1352-53 Students	1352-53 Teaching Staff	1351-52 Graduations
Tehran University	17,617	1,236	3,363
Tabriz University	6,998	502	1,195
Esfahan University	4,263	255	724
Gondi Shahpur Univ.	2,961	232	339
Mashad University	4,005	277	624
Arya Mehr Tech. Univ.	2,688	261	264
National University	6,276	309	1,089
Pahlavi Univ. - Shiraz	4,050	397	675
Higher Ed. Insts, Public	44,002	1,090	15,070
Higher Ed. Insts, Private	30,254	466	2,985
TOTAL	123,114	5,025	26,328

Source: Statistical Year of Iran, 1352 [March, 1973-March, 1974] Plan and Budget Organization, Statistical Center of Iran, June 1976.

In most of the applications studied, including Pahlavi University, the students view the television either where they live or in some public place. Where this is done, introduction of television will also reduce the classroom expansion needed to accommodate increased student enrollment.

In Pahlavi University's experience, three courses, Business Economics, Psychology I and Farsi were broadcast in the Spring of 1975. Initial signup for these totaled 6,000. 2,000 students continued the courses throughout with 1,800 passing the final examinations. Additional courses have been added in the current year.

Faced with a need for a rapid growth of student enrollment, Iran's universities and colleges can look to similar uses of television as a means to help achieve the expansion with less growth of faculty and facilities.

C. IMPACT ON A TYPICAL CURRICULUM

On a course-by-course basis, the savings in faculty and classroom space can run as high as five to one; i.e., some courses offered with television require one-fifth as many faculty and classrooms as would be required for a normal lecture course. However, the savings vary greatly with the type of course, the number of students enrolled and the production technique used. These factors vary with the institutions studied (Appendix A) and can be expected to vary for different Iranian institutions.

In order to determine the full impact of television on university staff and classroom needs, it was necessary to study a typical college curriculum in detail. The number of students in any course will vary depending on whether it is a basic core course required of most majors or a specialized optional course in one discipline. Television may bring savings of faculty and classrooms in lecture courses but the increased student enrollments may require unrealistic increases in faculty or classrooms for non-television courses. To obtain a view of the total impact on such factors, a curriculum was studied on a course-by-course, program-by-program basis.

The curriculum of Pahlavi University of Shiraz was used for the study. In size and complexity, the Pahlavi curriculum is similar to other universities in Iran and similar to many of the cases studied. The general conclusions derived from this study are thus felt to be applicable to many other universities in Iran. (A computer program was developed (Chapter II) to account for the variables. Because it was developed for general inputs, the program can also serve as a general planning tool for introduction of television to other institutions.)

In the study, it was assumed that television could only be used in normal lecture courses. Project courses, laboratories and workshops were assumed to be offered in the conventional way only. Conventional courses were assumed to be offered with student-teacher ratios typical of Iranian goals. Television lecture courses were assumed to require regular discussion meetings with faculty mentors. The number of discussion meetings assumed were high when compared with the cases studied and very high when compared with the number of meetings scheduled with the current Pahlavi television courses.

About half of the Pahlavi curriculum was analyzed, 630 separate courses comprising 17 degree programs in the Schools of Engineering and Humanities and Sciences. (Appendix C.)

The study assumed that the university was faced with rapid increases in student enrollment. The number of faculty needed for the enrollment and the increases in classroom capacity were estimated with various strategies for use of television.

A number of criteria for inclusion of courses in television were studied. The most important cases were ones which assumed a minimum number of students taking courses is required before it is put on television (a criteria used in several of the institutions studied). This criteria selects the most common core courses with largest enrollments to be offered on the television. Upper level courses and special options tend to be taught in the conventional way. As previously stated, all laboratories, project courses and workshops were assumed to be taught conventionally.

The results of most importance are summarized in Table I-3 and I-4. Student enrollment in these cases is assumed to increase from 2,920 to 8,760. The number of faculty and classroom facilities needed to teach the students are shown for various numbers of television lecture courses running from 16 to 143 per semester.

Table I-3

Summary of Staff Growth Needed for Threefold Increase in Student Enrollment

Student Enrollment	Students per TV Course	No. TV Courses each Semester	TV Faculty	Mentor TV and Regular	Regular Lecturers	Laboratory Staff	Seminar Project Faculty	TOTAL FACULTY
2920 (current)	--	0	0	24	136	43	5	208
8760 (5 years)	--	0	0	72	407	136	15	624
"	500	16	4	75	234	136	15	464
"	300	29	7	76	176	136	15	410
"	200	44	12	77	127	136	15	367
"	100	143	36	84	2	136	15	272

Table I-4

Summary of Facility Growth Needed for Threefold Increase in Student Enrollment

Number TV Courses per Semester	Normal Lectures		Television Discussion		Total rooms Lecture & Discussion	Laboratory		Total Rooms Lecture & Discussion Laboratory
	room hrs/week	rooms (1)	room hrs/week	room (1)		room hrs/week	rooms (2)	
Before student increase	958	32	---	--	32	1088	20	52
After 3x increase								
Number courses	2974	96	---	--	96	3275	68	164
16	1622	54	410	13	67	3275	68	135
29	1226	41	542	18	59	3275	68	123
44	890	30	654	22	54	3275	68	120
143	12	1	946	32	33	3275	68	101

(1) Lecture or meeting rooms are assumed to be scheduled 6 hours per day, 5 days per week.

(2) Laboratory rooms are assumed to be scheduled 9 hours per day (morning, afternoon and evening schedules), 5 days per week plus one 3 hr session on Thursday.

Without television, the faculty and classroom expansion needed is 200%, proportional to the increases in student enrollment. With television, in only 44 lecture courses per semester (only 14% of the courses) the faculty increase is only 76%, the facilities increase is only 123%.

Most of this growth is due to expansion of laboratory resources, which are not effected by television. Considering lecture, seminar, and project resources only, the threefold increase in student enrollment is accomplished with only a 40% increase in lecture related faculty and a 70% increase in lecture and discussion rooms. (See Figs. I-1 and I-2.)

D. TRANSITION CHARACTERISTICS

Television used in the larger lecture courses will shift faculty teaching responsibilities to a different set of courses and require growth of faculty in certain capacities. The rates of these changes would have to be accounted for in staff planning.

Figure I-1 projects the numbers of faculty needed in different capacities as television is introduced into the curriculum and the student enrollment is allowed to increase to three times the original value. The case shown is for a maximum of 44 television courses per semester.

By the fourth year, twelve equivalent full time faculty offer the television lecture courses. (Note that faculty in these projections are "equivalent full time faculty"; any given professor might have part of his time assigned to one type course and part time to another.)

The faculty teaching normal lecture courses decreases slightly. (The total of television and non-television lectures stays about the same.) The main change in faculty assignments for normal lectures is that the faculty shifts towards more teaching of junior, senior and fifth year courses and less of Freshman and Sophomore commom core courses.

Mentors (advanced student teaching assistants) triple along with the threefold increase of student enrollments. About two-thirds of the mentors are related to the television lecture courses. The remaining third are teaching assistants for the normal courses.

Most increase in staff comes from the laboratory, seminar-workshop, and project courses, which are assumed to be inappropriate for television. Staff for these increases by three times as the student enrollment grows.

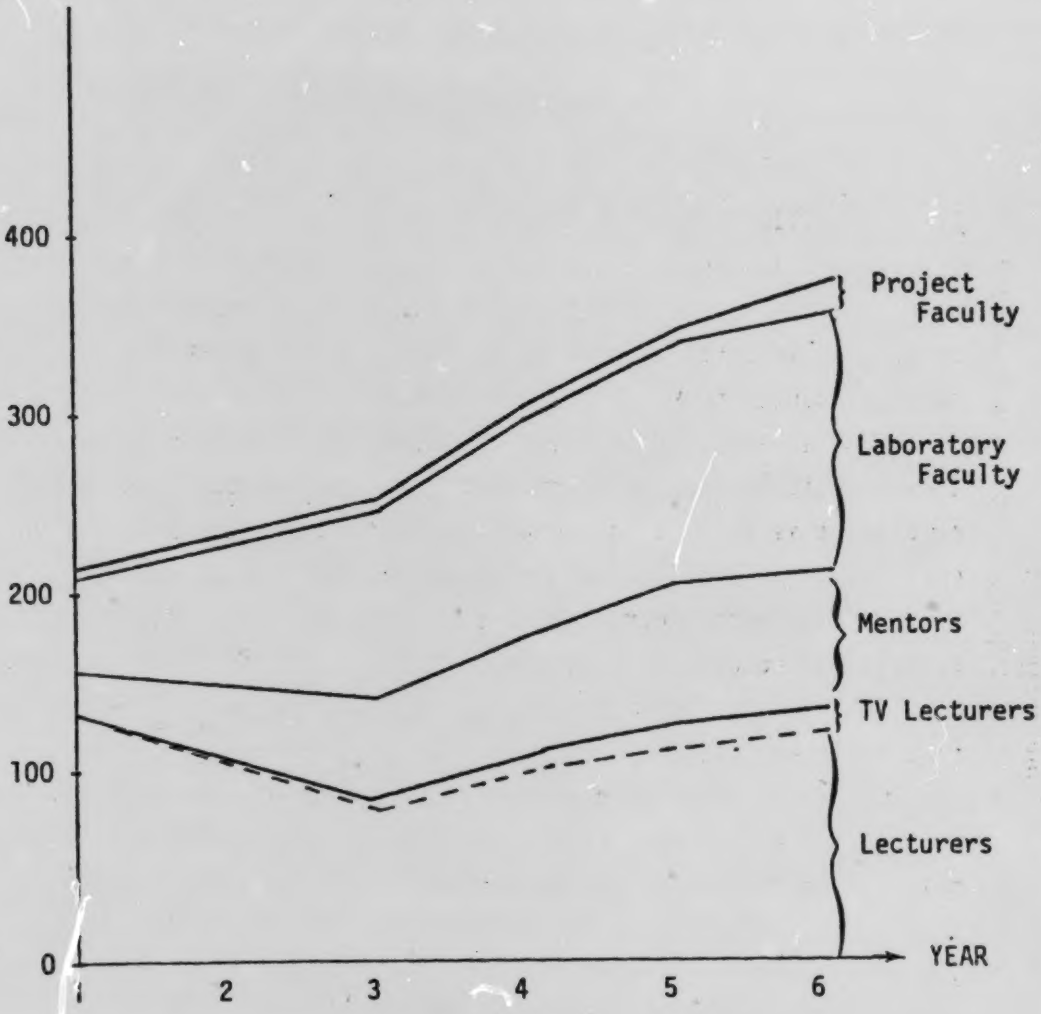


Fig. I-1 Faculty Growth with TV in 44 Courses Per Semester

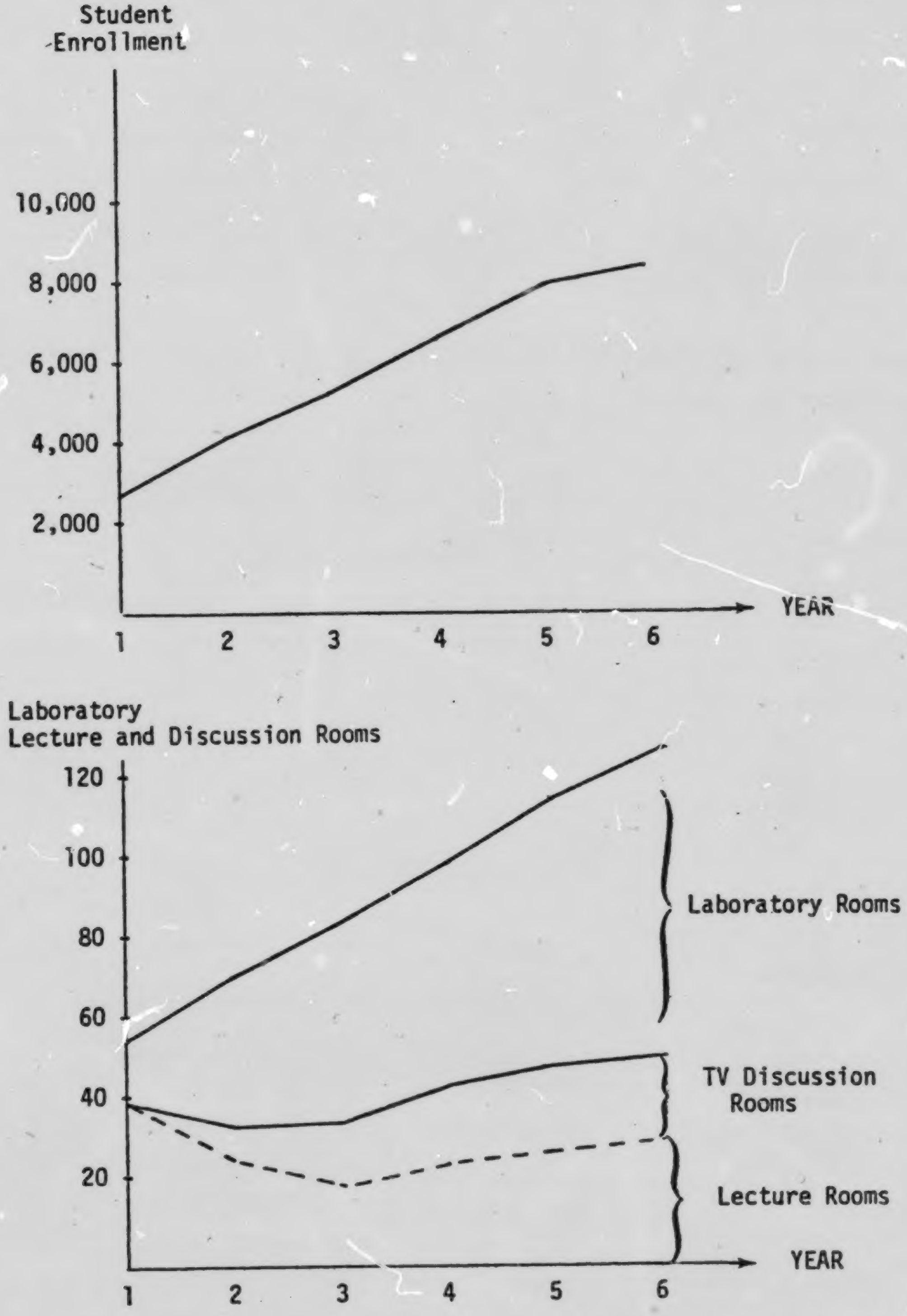


Fig. I-2 Student and Facility Growth with TV in 44 Courses Per Semester

The facilities growth is shown in Fig. I-2. The classroom space needed (not including laboratories) increases only 40% in contrast to the 200% increase that would be needed if television were not used. Classroom increases include rooms needed for discussion meetings of the lecture courses. (The increased classrooms could possibly be off-campus facilities more convenient to the students enrolled in the television courses.) Laboratory facilities must increase threefold. This will represent the major facilities bottleneck in such a rapid expansion; since television has not been shown to be able to replace laboratory experience, laboratory facilities must expand along with student enrollment. (Recognizing its criticality, the need for laboratory facilities might be reduced by modifying curriculum requirements, scheduling summer laboratory sessions, etc., but in any case, television will not itself reduce this facility need.)

E. TELEVISION PRODUCTION TECHNIQUES

The variety of television production techniques used in the institutions studied varies widely. Some used television studio techniques with full television crews, many graphics, remote filming, and frequent retakes. Others used simpler techniques. The student performance on courses is apparently not dependent on the production technique as long as the material is organized effectively as in a well taught, normal lecture and adequate provision is made for discussion sessions. Presentations very similar to normal lectures, "talking head" plus simple graphics or blackboard, do as well as normal lectures given by well prepared faculty.

Of particular interest in the studies was the contrast between production studio techniques and studio classroom techniques. Each technique is used by a number of U.S. universities.

In the production studio technique, a typical operation requires a studio staff of six or more: a director, switcher, sound controller, two or more camera men, and studio floor manager. With normal procedures and retakes, three or more hours are needed to record an hour of course material. Additional support crew is needed to record, playback and broadcast the resulting programs.

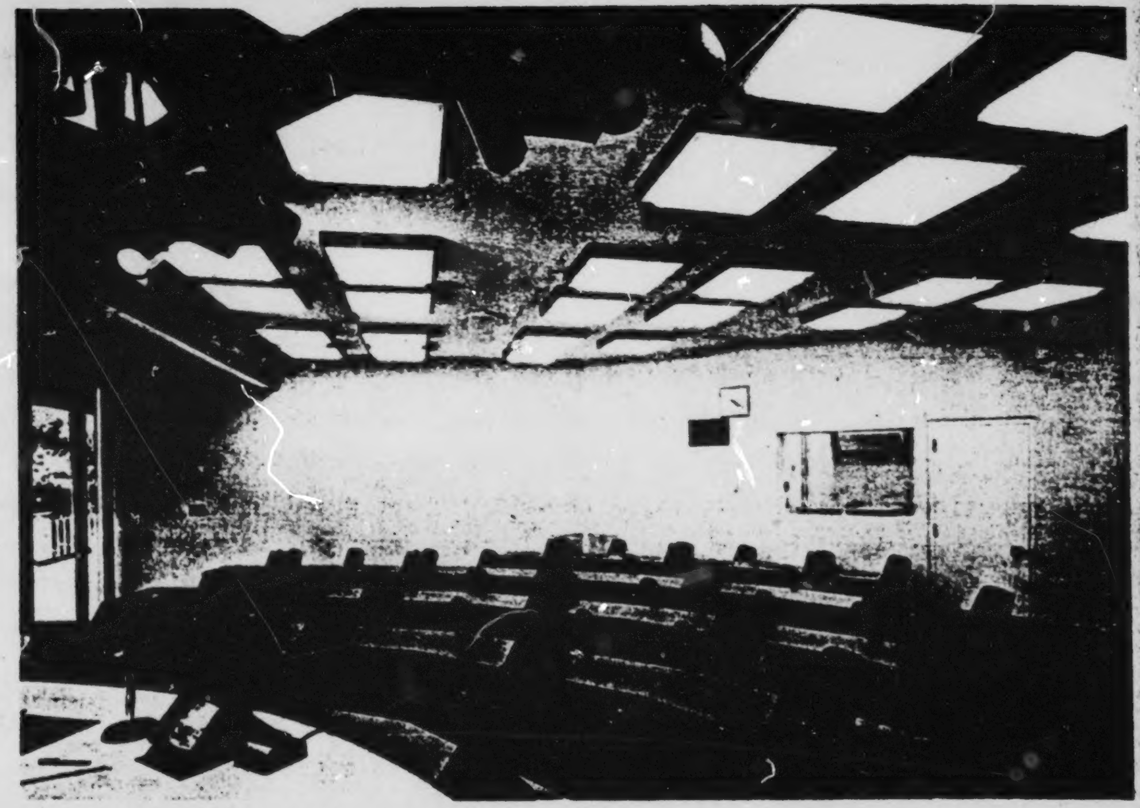
In the "studio classroom" technique, a normal room is equipped to seat a regular class and the lecturer. Two or three remotely controlled cameras are positioned to view the lecturer, illustrations or notes on his desk, and sometimes the class itself for discussion. A single operator (normally a student assistant with a week's training) operates pointing, zoom and camera selection controls from a control console behind a glass panel (see Fig. I-3). One hour of operator time corresponds to the lecture hour. A crew of four to six maintains equipment and operates recording and broadcast facilities for all the studio classrooms in the system.

The production studio requires 15 man hours or more of studio crew time plus the professor's time to prepare an hour long television program A studio classroom requires one man hour of studio crew plus the professor to prepare an hour long television program. The savings comes from careful design of the studio classroom facilities to suit the college course application. It has been designed to minimize changes in the professor's teaching technique and minimize the operator time required.

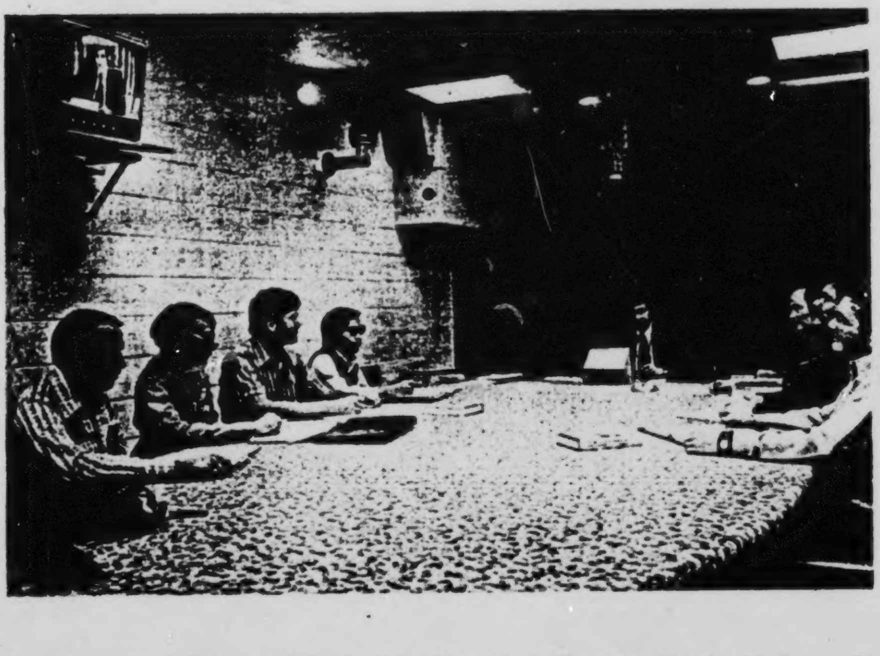
In light of the major differences in cost between the two techniques, Iran's need for a rapid expansion of university capacity, and the large number of course hours needed to have an impact, the studio classroom technique is strongly recommended for use in Iran's universities.

A summary of the studio classroom costs are shown in Table I-5. These costs include modifying from 1 to 11 classrooms to be studio classrooms plus modifying a central facility to monitor, record and broadcast the courses. The different number of classrooms relate to the number of courses offered per semester.

Once the studio classroom facilities are available, introduction of the television to the curriculum consists of selecting the better professors of each course and scheduling one section of those courses into the equipped classrooms. Experience of the institutions using studio classrooms indicate that if the professor has the course well prepared in lecture format, changing to the television format requires little modification. Since the studio classroom draws courses directly from the regular curriculum, the television courses can reflect improvements and changed emphasis in the university programs merely by scheduling different courses in the television classrooms. (Because of the costs in each television course, the studio production technique is less responsive to curriculum changes.)



(a) Stanford University ITV Classroom



(b) Seminar Room Equipped for ITV at Colorado State University

Fig. I-3 Typical Studio Classrooms

Table I-5

Studio Classroom Facility and Staff Costs

(a) Studio Classroom Cost Details (Color)

1	Switcher (Shintron Model 320)	$ 395
1	Screen Splitter (Telemation TSE-100)	800
1	Tray (Grass Valley 900T)	150
1	Power Supply (Grass Valley 900PS)	125
2	Video DA (Grass Valley 901)	400
1	Video Processor (3 M-P-100)	1800
2	Color Cameras (Shibaden HV-1500 w/est drive maintenance manual, no lens, c/mount + 50' cable)	7700
1	Subcarrier DA (Grass Valley No. 907)	300
2	Zoom Lenses (Vidon V-20-100 f. 1.8 w/control box)	1800
1	Pan/title unit (Tele-Cine 480 w/o control box)	450
2	TV Sets (Sony KV-1203)	650
3	TV Sets (Sony KV-1711)	1275
5	Optical Isolators (VACC A01 Model)	650
1	Kodak Carrousel Slide Projector Model 760 w/zoom lens	152
1	DaLite Video B 60" x 60" Screen (Pull Down)	39
1	Color Sync Generator (VACC Model 5000)	995
2	10" B & W Monitors (Setchell Carlson 10 M915)	380
1	Audio-Mixer (Sure M-67)	165
1	Oscilliscope (Tektronix 528 with rack mount)	1200
2	Camera Mounts (Delco UM-1)	84
1	Black and White Camera (Norelco EL 7000)	400
2	Joy Stick Switches (Power Optics No. 192)	100
2	VU Meters (Simpson 543)	70
3	Switches (Switchcraft XM-4577)	33
1	TV Tuner (Sony TVM-100)	300
2	Microphones (Sony ECM-200)	50
3	Telephones (ITT Kellog No. 65-02)	30
3	Telephone Hangers	24
	TOTAL	$ 20.514

* This equipment is typical of a U.S. studio classroom [Ref. 3]. The costs in Iran will vary somewhat because of the different video sysem and choice of black or white or color. In the cost estimates it is assumed that installed equipment will cost $30,000.

Table I-5 (continued)

Studio Classroom Facility and Staff Costs

(b) Components of Facility and Staff Costs:

Staff

Director	1
Engineer	1
Scheduler	1
Secretary	1
Technician	2
TOTAL	6

For each 4 classrooms add 1 Technician

For each 40 hours per week of courses add 1 Operator full-time equivalent

Average staff salary is assumed to be 1.26 million rial ($18,000)/yr.

Average Operator salary is assumed to be .63 million rial ($9,000)/yr

Facilities

(a) Classroom each see Table I-5 (a) $ 30,000

(b) Transmitter to cover 6 1/2 km radius (Ref. 4):

24 Meter Tower	$ 4,060
10 Watt Transmitter	13,770
Antenna Subsystem	3,000
I.F. Distribution	6,000
Installation	2,000

1st Channel	$ 28,930
Additional Channel	$ 24,870

(c) Central Control Facilities depends on operation. Approx. $ 40,000

Table I.5 (continued)
Studio Classroom Facility and Staff Costs

(c) Summary of Costs with Different Number of Classrooms and Courses

#Courses	#Staff	#Operators	Annual Salary Million Rials	#TV Rooms	Capital Cost Million Rials ($)	Maintenance @ 10%/yr Million Rials ($)	Annualization of Capital 10 yrs @ 12% Million Rials ($)	Total Annual Cost Million Rials ($)
16	6	1.5	8.5 (121,500)	1	6.9 (98,930)	.69 (9,900)	1.13 (16,100)	10.32 (147,500)
29	6	2.2	9.0 (127,800)	2	10.8 (153,800)	1.08 (15,400)	1.75 (25,000)	11.78 (168,200)
44	7	3.3	10.9 (155,700)	4	18.5 (263,540)	1.85 (26,350)	3.00 (42,900)	15.75 (225,000)
143	10	11.0	19.5 (279,000)	11	45.3 (647,600)	4.53 (64,760)	7.38 (105,400)	31.44 (449,000)

Experience has shown that the studio classroom television courses can teach as well as regular lecture courses for registered college students taking required courses. Periodic discussion meetings are required and normal provisions must be made for homework and examinations. There are applications outside of formal higher education where studio classroom might be important but these must be evaluated separately. Clearly, there are also non-formal educational television applications where the increased quality of studio production and remote filming are needed to present an effective message.

F. COST EFFECTIVENESS

As different numbers of courses are introduced into the curriculum of the "typical" university studied, the numbers of faculty needed are reduced. Since larger lecture courses are selected for inclusion first, successive additions of courses to the television system will result in smaller savings. Eventually, only courses with small single sections for which there is no benefit from television would remain.

Also, as additional courses are put on television, the classrooms and broadcast facilities must be increased. Additional capital is required and eventually limitations will be reached in broadcast frequencies available for transmission to normal television sets.

Table I-6 shows the savings in the numbers of faculty and staff that occur when anywhere from 16 to 143 lecture courses per semester are offered through television. It is assumed that regular faculty earn $18,000 per year, laboratory faculty $12,000 per year and mentors or teaching assistants $9,000 per year. Overhead and facilities costs are not included in these figures; they will vary from institution to institution but generally increase the savings over those calculated here.

Approximately $3,000,000 per year in salaries are saved when the largest 16 courses per semester are given through television. When the next 13 are added, small class size brings the savings down to 980,000 per year. The next 15 added bring savings of $750,000 per year. The final increment would add courses with as few as 100 students; it brings $1,760,000 per year savings only if 99 courses are added.

Table I-6
Summary of Faculty Salaries

#TV Courses Per Semester	ETV & Regular Lecture Seminar Project Faculty	Laboratory Faculty	Mentors	Lecturers Salary Million Rials ($ million)	Lab. Faculty Salary Million Rials ($ million)	Mentors Salary Million Rials ($ million)	Total Annual Salary Million Rials ($ million)
0	422	136	72	532 (7.6)	114 (1.63)	45 (.65)	692 (9.88)
16	253	136	75	319 (4.55)	114 (1.63)	47 (.67)	480 (6.85)
29	198	136	76	249 (3.56)	114 (1.63)	48 (.68)	410 (5.87)
44	154	136	77	194 (2.77)	114 (1.63)	48 (.69)	356 (5.09)
143	53	136	84	67 (.95)	114 (1.63)	53 (.75)	233 (3.33)

Lecturers salary is assumed to be 1.26 million rials, ($18,000) per year.

Laboratory faculty salary is assumed to be .84 million rials, ($12,000) per year.

Mentors salary is assumed to be .63 million rials, ($9,000) per year.

Table I-7
Savings with Different Numbers of Television Courses

#TV Courses Added Per Semester	Increases in Number of Courses Per Semester	Added Annual Cost to TV System Million Rials ($ million)	Annual Faculty Savings Million Rials ($ million)	Net Annual Savings Million Rials ($ million)	Net Annual Savings Per Course Added Million Rials ($ million)	Reduction in Number of Classrooms Needed
0 to 16	16	10.32 (.147)	212 (3.03)	202 (2.8)	12.6 (.18)	29
16 to 29	13	1.46 (.020)	70 (.980)	69 (1.0)	5.31 (.08)	8
29 to 44	15	3.97 (.060)	54 (.780)	50 (.71)	3.33 (.05)	7
44 to 143	99	15.69 (.22)	12[illegible] (1.760)	107 (1.53)	1.08 (.02)	19

Table I-5 summarizes the costs of the studio classroom facilities needed for these courses. For the cases described above, one studio classroom and transmitter are adequate for 16 courses per semester. Two are needed for 29 and four for 44 courses per semester. Eleven channels and television classrooms would be needed to carry 143 courses per semester. (This exceeds the number of channels that can reasonably be made available.)

Table I-7 summarizes the added costs of the television system (staff and capital) and savings in direct faculty salaries for different numbers of courses added. The reduction in classroom requirements is shown also but no dollar value has been assigned to it. (While facility savings would be significant, it is much less than savings in faculty time.)

With the Pahlavi curriculum, the savings per course addition decreases very rapidly as the largest core courses are added to television and only the smaller more specialized courses remain. Somewhere above 44 to 50 television courses per semester, student enrollment will fall below two hundred per course in the remaining lecture courses and savings per course added to television are correspondingly small.

The initial step into one channel of educational television would cost about $100,000 in capital investment and add about $122,000 per year in salaries for the staff to operate the studio classroom facility. By scheduling approximately 16 core courses per semester into these facilities, there would be a reduction by about 160 in the faculty needed to meet a threefold increase in student enrollment.

The annual savings represent about $3,000,000 per year while the costs annualized are only $147,000 per year. There are still very large benefit cost ratios from adding classrooms up to a total of about four, able to broadcast about 50 courses per semester. Between 16 and 44 courses per semester on television, faculty needed are reduced by another 100. Above 50 courses per semester, the benefits reduce significantly and further addition of courses to television may or may not be justified. Above this level there is also questions of frequency availability for broadcast that must be answered.

On a cost benefit basis then including video-classrooms in a university is well warranted. With a curriculum of the breadth of Pahlavi

University's, at least four video classrooms are warranted. These would carry up to 50 classes per semester on four broadcast channels.

The inclusion of video classrooms can also be viewed from faculty availability. The needed expansion of university capacity can only be met in a conventional way if sufficient qualified university faculty can be found. This is the main bottle neck in the expansion of Iran's higher education. The introduction of television courses will reduce by almost half the number of faculty needed to meet a threefold expansion of student enrollment.

G. ADDITIONAL APPLICATIONS

Use of television studio classrooms for teaching of core lecture courses has been shown to be very attractive for a university with a student body growing to about 12,000 students and a curriculum similar to Pahlavi University's. Similar benefit will come from the addition of video classrooms to other universities.

The benefits are high when there are over 200 students per television lecture course. The number of courses with 200 students or more in other institutions will depend on the total student enrollment and the form of the curriculum. The planning program described in Chapter II can be applied to the curriculum of any university to estimate the impact.

It is certain, however, that benefits similar to those described above would be found for Iran's ten or so largest institutions of higher education. Introducing television to these institutions would come close to matching the demand for college graduates called for by Iran's projected economic growth and do so with reasonable increases in faculty.

The expansion of basic university enrollment is felt to be the most important application for the studio classroom given Iran's current economic development needs. Therefore, the analyses and discussion have focussed on the core university curricula and formal education systems.

There are other applications in the cases studied that would also be important to Iran.

Because the courses would be broadcast generally in the cities, the general public would be able to participate less formally and benefit from much of the material.

If provision is made for discussion meetings, part-time students may benefit from a specific sequence of courses aimed at developing a skill but not leading to a full university degree (a university extension application).

With the basic freshman courses offered over television, advanced high school students could take a number of required university courses in the final year of high school and achieve advanced placement in the university.

The Pahlavi television experience has included students in all three catetories above. Branch campuses of universities can broadcast the televised courses recorded at the central campus facility. This would increase the effective number of students for each television course, increasing the savings. The savings would be partially offset by the added video tape and broadcast facilities needed; but the net savings would be similar to those calculated for the full campus. In such an application, the branch campus staff would provide discussion and credentialing for the lower year television lecture courses and normal teaching for advanced courses, laboratory, workshop and project courses.

The studio classrooms can be used to offer courses for professional improvement of people already in mid-career. Though these are typically more advanced courses with fewer students, the benefit of reaching the professionals in their homes or businesses may warrant the extra costs.

The use of the video classroom can be shown to be effective in many applications such as those described above. The low investment cost $100,000 to $300,000 in comparison to the savings in faculty will be attractive for many medium to large institutions and will undoubtedly lead to limitations imposed by television broadcast frequency availability, especially in Tehran. In introducing the video classroom technique, priorities will have to be set for use of the normal broadcast bands. Such precedent might be based on relative importance of achieving national goals. Frequencies other than the normal broadcast bands can be assigned but will require special television receivers and, therefore, a review of the cost benefit estimates.

H. CENTRALIZATION OR DUPLICATION

The use of video classrooms becomes more efficient the larger the institution. This argues that at least from the quantitative standpoint the largest institutions should introduce television and increase staffs to rapidly expand their enrollments rather than the medium sized and smaller institutions. There are counter arguments to this position however. Though not fully quantifiable, these arguments are probably the overriding considerations in deciding which institutions could expand their enrollments using television.

In the actual situation, the question could come down to choices of expansions of one or two of the largest institutions with the help of television or expansion of ten to fifteen smaller institutions.

Factors to be considered in such a decision include the following:

- Very great benefits can come from introduction of television into institutions with 4,000 to 10,000 students. Even smaller institutions can benefit greatly if their curricula are simple. While larger institutions have a potentially greater benefit, on a per student basis, the added improvement is marginal and should not be a major factor in deciding between large and small institutions for television expansion.

- The capital investment to add studio television classrooms to ten institutions would be about $2.5 million. To add classrooms to only two large institutions would be about $0.5 million. If either technique were used to increase enrollments by about 100,000 students, the direct faculty salary savings would amount to over $40 million per year. The cost that would be potentially saved by centralizing the curriculum are very small in comparison with these benefits. Thus, cost savings is a very weak argument for a more centralized curriculum.

- Television in the formal higher education institutions studied is part of the existing institution. It efficiently substitutes for only part of the courses, 10% to 20% in the cases presented above. For efficient development it draws from the existing curriculum rather than creating new ones. The students have normal interactions with faculty in lecture courses, in discussions and testing on the television courses, and in normal counseling and credentialing. The complex part of higher education expansion is developing the normal curriculum and assembling the staff and administrative structures. Given Iran's need for rapid expansion of higher education it would seem more feasible to expand the capabilities of existing medium size institutions rather than creating a much larger staff and administrative structure for one or two national institutions using television.

- Higher educational institutions to some degree specialize to meet local needs and to create excellence in particular fields of study. The structure of the curriculum and relationship of courses to prerequisites reflect these emphases. Television used with many smaller institutions would preserve the value of this specialization.

- Many of the extra benefits in less formal use of the television courses require broadcast in many cities not just one or two major ones. This favors use of television in several more local institutions not just one or two national centers.

- A long process of reviewing local and national needs has gone into the current definitions of areas of responsibility and budget allocations in higher education. Introduction of television into ten or fifteen institutions could lead to the higher education enrollments needed by the economy without major redefinition of areas of responsibility or budgets. Similar expansion based on major growth of only one or two institutions would require major redefinition of budgets and areas of responsibility. The potential delay required by such redefinition would be a serious block to the application of television in higher education.

While most of the above factors cannot be explicitly quantified, taken together they argue strongly for a decentralized approach. Introduction of television to ten to fifteen of Iran's existing institutions of higher education would appear able to meet the country's needs more efficiently than trying to achieve a very major expansion through rapid growth of one or two national institutions.

I. CONCLUSIONS AND RECOMMENDATIONS

The results of experience with television in credentialed university education indicates that, used in a simple straight forward way, television can very greatly reduce the faculty required to teach students. Lectures through television when properly accompanied by discussion with live mentors, teach as effectively as normal lecture courses in most situations. Laboratory, workshop and project courses have not been shown to be susceptible to a television format.

Iran's economic growth requires an increase in college graduations two to three times more than can be accomplished with planned expansions using conventional lectures. Television introduced to the core curriculum courses in ten to fifteen of the major universities will allow the demand to be met with a small increase in faculty and facilities, increases consistent with allocated resources.

The simplest way to introduce effective television to an existing curriculum is through construction of a studio classroom television facility on the campus. Courses with high student enrollment are then scheduled in the classrooms and broadcast to the students in the local community. In this way, there is no investment required in curriculum development, usually the most costly and time consuming part of television application. The television classroom draws from the existing developed courses, some improvement on the existing curriculum will even be accomplished by selection of appropriate courses and faculty for television.

Because of the integral relationship between the television and the curriculum in this application, it is recommended that the full responsibility for operation of the television system be the responsibility of the educational institution.

There are three roles that NIRT could play in implementing the classrooms:

1) They can institute a demonstration video classroom available in Tehran for use of local institutions. This would be useful to provide limited courses through television that can then be evaluated for effectiveness with different courses and student mentor approaches. These facilities could also serve for initial operational uses for institutions that are planning or building their own video classrooms within one or two years.

2) They can provide faculty and facilities planning support for institutions considering television use. A major difficulty with television courses is the load they put on the following courses that are not televised. The dangers are large and not obvious. The planning program provided can be used with the curriculum planners of the institution to obtain revised facility and staff plans.

3) They can make the broadcast equipments and possibly television classrooms available to the institutions that are interested in broadcasting their courses and are large enough to benefit from television classroom use. The cost of doing this will be about $250,000 per institution.

CHAPTER II

THE COMPUTER BASED PLANNING PROGRAM

A. INTRODUCTION

The purpose of this chapter is to present a planning process for the expansion of university education programs using educational television and to describe a case study that highlights some of the key considerations in the implementation of effective programs.

Successful use of educational television at the university and college level has been demonstrated in a number of cases throughout the U.S. and other countries. These successful operations have shown that television, by replacing a live lecture, allows increases in student/teacher ratios by factors of two, three, and even four. In addition, by the use of less highly trained mentors for student interaction, tutoring and administrative duties, it is possible to greatly increase the number of students handled by a fully qualified faculty member. Mentors are individuals well versed in the subject matter of the course being taught but without the strong academic background and experience of a faculty member. At the university, the mentor corresponds to the traditional role of a teaching assistant, from upper level undergraduate classes or the graduate level. The combination of higher student/teacher ratios and extensive use of mentors enables the number of students handled by a single faculty member to be increased by factors as high as 20 or even 30. A detailed review of ETV use and an assessment of its potential in reaching more students can be found in Appendix A.

In order to carry out this assessment, a planning tool has been developed in the form of a computer program. This program allows planners to determine the extent to which enrollments can be increased with television and the necessary changes in faculty and facilities at the university. The Pahlavi University curriculum was used as a model to illustrate the planning program.

The following sections describe the problems involved in expanding university education through educational television, the approach taken in analyzing the problem and developing the computer program, and the results obtained with the program. The appendices contain a description of the computer program itself and a listing of the degree programs that were included in the analysis.

B. PROBLEM DESCRIPTION

University expansion with educational television can be very large. Pahlavi University had 2,000 students complete three courses in the Spring of 1975. Having provided the three courses to those students, the question now must be raised as to what opportunities there are for the students to follow through and continue their university level education. If there is a commitment to provide those educational programs, then there are additional questions relating to the necessary staffing and the provision of facilities.

If educational television is to be used to allow large enrollments in university degree programs, care must be taken so that the combination of television-based and conventional classroom courses have adequate openings so that a student beginning with the television programs can complete his education in a reasonable time period. The use of television actually reduces faculty requirements in certain course areas--particularly where the courses in question are common among several degree programs. Those faculty may be available to help teach other conventional courses which will have to accept large numbers of students coming from the television courses. In the case of facilities, it may be necessary to reallocate the use of classroom space on the campus if a large proportion of lecture courses are carried via television. The main emphasis for facilities may be for seminar, project and laboratory classes. Finally, it is necessary to consider the capacity for production and broadcasting of television programs. If capacity is limited, a choice would have to be made as to which courses have the greatest impact when televised.

In Iran, certain degree programs should have priority for expansion in order to assure full economic development. These should be the focus of activities to develop educational television and provide rapid increases in enrollment. Identification of these degree programs can be made following the type of economic analysis presented in the report on identification of educational bottlenecks in economic development [1]. Generally, the areas needing the greatest expansion are the professional, technical, management and administrative fields.

C. APPROACH

1. Structure of the Computer Program

A computer program has been developed which computes television production requirements if educational television is used to expand enrollments at a university. Estimates are also made of the staffing requirements in terms of lecture, seminar, project and laboratory course assignments for professors and mentors (teaching assistants). The program also estimates corresponding facility needs.

The program has been designed to provide this information for a wide range of educational television use. Staff requirements can be determined for a totally conventional series of courses or for a series where all courses suitable for television are in fact televised.

Figure II-1 gives a simple representation of the program. The input data specify the degree programs to be examined; limits, such as a minimum number of students, on the selection of courses for educational television; student enrollments over time; and staff requirements as a function of the type of course, whether or not it uses educational television and the number of students. The computer has in storage or on punched cards the degree requirements for courses as well as a complete listing of all the courses. The latter are characteristics such as department; whether lecture, seminar, project or laboratory; and the number of credit hours.

When a degree program is specified the computer lists out all of the courses to be taken. An estimate is made of television production in hours of programming, and staff requirements are determined as a function of how much educational television is used and the number of students enrolled. The facility needs are determined in terms of the number of room hours per week needed for classroom meetings and laboratory sessions.

Where more than one degree program is specified, the computer first searches the full list of courses to assess television production, staffing, and needs for one course. The computer then reviews the list again for the next degree program, adding to television production needs only for courses not included in the first degree program. Wherever possible,

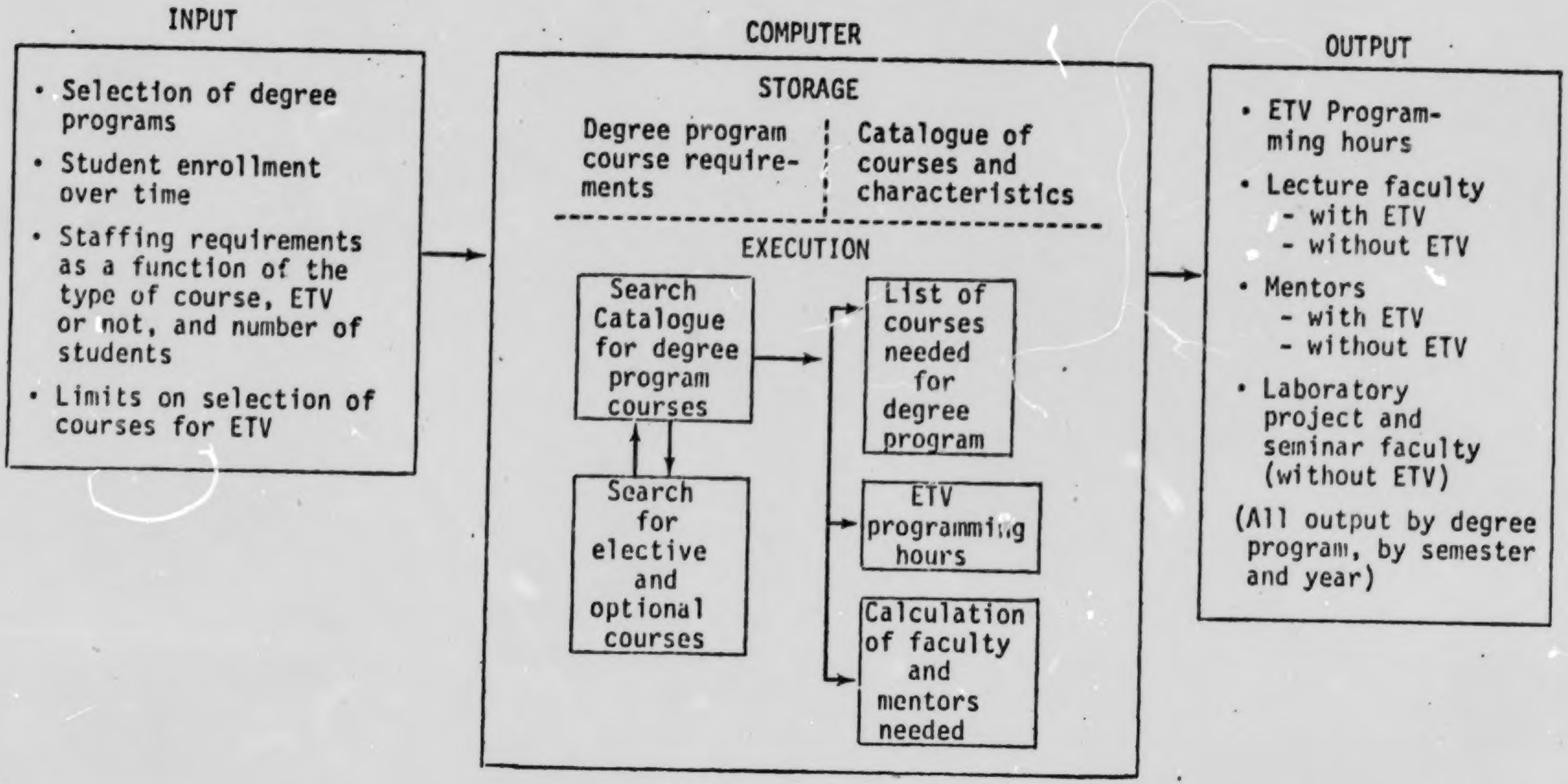

INPUT
• Selection of degree programs
• Student enrollment over time
• Staffing requirements as a function of the type of course, ETV or not, and number of students
• Limits on selection of courses for ETV
COMPUTER
STORAGE
Degree program course requirements
Catalogue of courses and characteristics
EXECUTION
Search Catalogue for degree program courses
Search for elective and optional courses
List of courses needed for degree program
ETV programming hours
Calculation of faculty and mentors needed
OUTPUT
• ETV Programming hours
• Lecture faculty
- with ETV
- without ETV
• Mentors
- with ETV
- without ETV
• Laboratory project and seminar faculty (without ETV)
(All output by degree program, by semester and year)

Fig. II-1 Computer Program Functions

television production needs are minimized by assuming courses already selected for educational television can serve as options or electives. Staffing needs are adjusted to account for students from more than one department attending a given course.

A listing of the program is contained in Appendix D.

2. Modeling the Degree Program

The definition of degree programs for use in the computer analysis is a complex problem. The framework for the analysis is rooted in the university structure. Universities are traditionally organized into colleges grouped around specific disciplines, professions or fields of study. Pahlavi University, for example, consists of six colleges--arts and sciences, agriculture, engineering, dentistry, medicine and veterinary medicine. Each college operates semi-automatically although certain policies are held in common.

Colleges are further divided into departments, each of which represents a discipline. Standards for granting a degree are established by the college and for a particular discipline by the appropriate department.

A degree candidate normally must complete 120-130 hours of study within an eight-semester period. (In some fields, more than eight semesters are required.) These credit hours must be drawn from four categories: common, those required of all degree candidates in the university regardless of field of study; major, those credits which must be earned by all candidates in a specific discipline; optional, chosen from a range of courses within the candidate's department or from related departments; and electives, which may be chosen according to the candidate's own interests from all departments of the university. The number of credit hours required in each category is usually specified by the department.

In establishing the model two colleges at Pahlavi have been examined as prototypes for the broader projects. One is the high-structured program of the College of Engineering. The other is the College of Arts and Sciences which gives students wide latitude of choice in pursuing a degree.

In each college we have listed all courses required or elected in each department. They are identified as lecture, seminar, project or laboratory, and information included on the number of credit hours, the year and semester in which the course is to be taken, and whether a course can be classified as common, major, optional or elective.

Several problems presented themselves in constructing the model: course titles sometimes did not indicate the department from which the course originated. The same subjects were offered in different departments under different titles. Departments did not always agree on their definitions of options and electives.

A particular note must be taken with regard to options and electives. Each department specified optional courses from which a degree candidate might choose, usually classifying them as Optional A (courses selected from the major department) or Optional B (courses selected from related departments). (In some departments, the designations were reversed.)

In some instances where the range of Optional B in one department comprised approximately the same courses as another department, the same range was used for both departments in order to minimize television production.

Electives fall into three groups, although they are not formally classified that way. These are social-science or humanities electives, general electives and technical electives. All students are required to take one social science course in the first year, chosen from a given range. To minimize production, we arbitrarily assigned History of Science 100 as the common social science course. General electives were limited to those courses already produced for other departments. Technical electives, in this case unique to the College of Engineering, were produced as indicated if these courses seemed basic to the student's specialty.

The lists of courses for the School of Engineering and Arts and Sciences are given in Appendix C.

3. Staffing and Facility Assumptions

The staffing requirements and facility needs can be provided to the computer programs with whatever assumptions the planner wishes to make. In the runs made with the Pahlavi curriculum, assumptions have been made that are felt to be typical of Iranian universities for normal courses. In staffing for television lecture courses the use of mentors that is assumed is conservative in comparison with many of the cases studied and with current practice of Pahlavi University. That is, television lecture courses have been offered with much less use of mentors than assumed below. The staffing assumptions are as follows:

- Normal Lecture Courses

  When a large number of sections are required, the average section is assumed to be 40 students. If only 60 students take a course it is assumed that one section is still adequate. More than 60 students calls for two sections or more. One quarter faculty time (10 hours per week) is assumed necessary to each one section of a 3 unit course. When more than one section is required of a faculty the second section is assumed to be taught by the faculty at 3/4 to load of the first (7.5 hours per week). A third section requires another 1/4 time faculty (10 hours); a fourth another 7.5 hours; and so on until all sections are covered.

  A teaching assistant (mentor) is assumed for each lecture course. For a 3 unit, forty student section, three hours per week are assumed to be needed. That is, one section requires about a 1/13 time student assistant.

  The staff requirements for shorter or longer courses are assumed proportional to the number of units required. Thus, a 5 unit course would require 5/3 x 10 hours or 17 hours per week of a faculty person's time.

- Televised Lecture Course

  A televised lecture course requires a faculty lecturer whose time commitment is independent of the number of students and a number of mentors for discussion, homework and testing that is dependent on the number of students.

  The faculty time required is assumed to be 1/4 time (10 hours per week) for a 3 unit course each time the course is offered. This is the same as the time required for a section of a normal course. For a video classroom production technique (which translates lectures directly to television) this implies that courses are not recorded for successive replay in the following years. For studio production techniques, which require more time of the faculty, this is consistent with the assumption that the course is taped and used for three or four years. The television facility operating staff is dependent on the total number of courses offered and the production technique and is calculated separately. The number of mentors required for the television course is calculated as follows: Each 3 unit course requires three hours per week of mentor time per course plus an additional three hours per week for each forty students enrolled in the course. Thus,

a course with 200 students would require eighteen hours per week, about a half-time mentor. A television class with 1500 students would require about three full time teaching assistants or more typically, six half-time teaching assistants.
As with the normal courses, the faculty and mentor time is assumed to be proportional to the number of units of the course. Thus, a 5 unit course takes 5/3 times the number of faculty and mentor time described above for a 3 unit course.

- Seminar Courses

  Seminar courses (meaning general information presentations without discussion, homework, etc.) are assumed to take 5 faculty hours per unit of credit per week for each 200 students without television. With television the faculty time is assumed to be the same, 5 hours per week per unit, but without a limit on the number of students enrolled. No mentor time is assumed for either case.
  (Though not a major factor in the case studied, the television seminar might be of more interest to an external, secondary, non-formal community audience for general interest subjects.)

- Laboratory and Workshops

  Laboratory and workshop courses are presumed to be taught in 12-student sections. One unit of such courses require five faculty hours for each 12-student section. It is assumed that laboratory and workshops cannot be taught at all with television.

- Project Courses

  Project courses taught with direct supervision of each student is presumed to require about 1/48 of a faculty time for each student unit. Thus, 3 units of project time for a student would require about 3 hours of faculty time per week.
  This project time is meant to be representative of undergraduate or fifth year project courses and not graduate research projects. The project courses are not effected by television.

- Classroom Facilities

  The classroom facilities are estimated in terms of the classroom hours needed per week. A classroom is presumed to be able to seat at least 40 students and where needed a few can seat up to 60 students.
  One room hour per week is assumed to be needed for each unit of credit and each section of a lecture course. In estimating actual rooms required, the room hours per week need to be divided by the number of hours per week that a typical room can be efficiently scheduled.

- Television Course Discussion Rooms

  Television meeting rooms are intended to provide meeting space for discussion sessions between the mentors and the students taking a television course. It is assumed that each 3 unit course schedules one 1 hour meeting per week for each 40 students. (The classroom hours per week is given by the number of students divided by 40 and multiplied by one-third of the number of course units.)
  As before, the classrooms required can be given by dividing classroom hours by the number of hours per week that a room can be efficiently scheduled.

- Laboratory Facilities

  Laboratory facilities are estimated as follows: Each one unit of a laboratory course is assumed to require three hours of time in the laboratory by the student. Each laboratory is equipped to handle no more than twelve students at a time. Therefore, laboratory hours per week is given by three times the number of units multiplied by the number of students divided by twelve.

  The laboratory room hour requirements are the same whether the laboratory is a scientific equipment facility or a discussion room for a workshop type "laboratory."

  The number of laboratory rooms is equal to the laboratory hours divided by the hours per week that a laboratory can be effectively scheduled. Typically, laboratory scheduling is more difficult than lecture courses because of the 3 hour sections. In interpreting the example run, it was assumed that three sections of 3 hours each could be scheduled each week day, one morning, one afternoon, and one evening session. One extra section is assumed to be given on Thursday.

Because scheduling practice will vary from institution to institution the facility needs are given in room hours per week. Thus, each institution can translate this into an equivalent room requirement reflecting its policy on day and night classes.

D. CASE STUDY ON COLLEGE CURRICULUM

To determine the impact of televising lectures on a typical curriculum, the course structure of Pahlavi University has been used. The schools of Arts and Sciences and of Engineering are included. These account for about half of the enrollment in the university. All together these schools have 630 courses in the undergraduate curriculum. Each school has a number of departments listed in Table II-1. Computer course codes listed on the table are used to identify the department offering each course. The courses and departmental requirements for different degrees is listed in Appendix C.

Altogether there are 17 degree programs offered by the two schools (5 of five years and 12 of four years). For the example to be described, it was assumed that initially there were forty students in each year of each degree program. The case assumes that a tripling of student enrollment is to be achieved by adding 80 students to each program in the freshman class each year, i.e., the entering class is 120, and then let this increased enrollment step up through advanced years. With this rate of increase the total enrollment goes from 2,920 to 8,760 by the sixth year.

The numbers of students in each course is determined by the number of times the course is required in the different programs. Core courses, for example Persian 101 and Mathematics 101, are required by most degree programs and have very large enrollments. Higher level courses, for example History 411 or Nursing 301, are required only of specific degree programs and have much lower enrollments.

The number of students expected for each course was calculated from the degree program requirements and then the faculty and facilities needs were calculated using the relationships described above.

Various assumptions were made for criteria to include courses in the television presentations. The most important criteria was a lower limit on the number of students required before the course was aired. This selects the largest courses for television where the benefit is greatest. Nothing but lecture courses were selected for television.

When 500 students were required per television course only the largest common courses were scheduled for television. The courses selected are shown in Table II-2. Besides the specific courses, there would be another three or five courses with high enrollments due to students favoring particular courses in selecting out-of-department options.

When the per course student enrollment must be greater than 300 students, other courses are added to the television schedule. These added courses are shown in Table II-3. These are still first and second year

Table II-1

Schools and Departments of Pahlavi University

Department	Computer Course Code
School of Arts and Sciences	
Economics	100
Business	101
Nursing	110
Education	160
Psychology	161
Biology	190
Persian	220
History	120
Physics	140
Music	170
National Development	200
Sociology	201
Mathematics	130
Geology	150
Chemistry	180
Modern Languages English	210
Modern Languages French	211
Modern Languages German	212
Modern Languages English Literature	215
School of Engineering	
Material Science	230
Chemical Engineering	240
Mechanical Engineering	250
Civil Engineering	260
Electrical Engineering	270

Table II-2

Courses Selected for Television with >500 Students

Persian 101 and 102
Modern Languages-English 101, 102,201 and 202
Sociology 201 and 202
Chemistry 105 and 106
Mathematics 103, 104, 105, 106, 201, 202, 205, 308, and 309
Physics 105, 106 and 107
History 101 and 102
Biology 101
Civil Engineering 221 and 323
Electrical Engineering 222 and 282
Popular Options 3 to 5 courses

Table II-3

Courses Added to Television When Enrollment Limit
is Reduced from 500 to 300 Students

Sociology 203
Chemistry 221, 222 and 341
Mathematics 101 and 102
Physics 103, 326, 432 and 441
Biology 102
Civil Engineering 222
Mechanical Engineering 341
Psychology 203
Economics 201 and 202
Popular Options 3 or 4 Courses

courses mainly, but now a number of courses have been added that are not common courses but are courses required by several departments.

When the course requirements for television is reduced to 200 enrolled students, the courses added are those shown in Table II-4. Most of these courses are upper-division courses required of most majors in a particular department. In this analysis, simple choice of options and an equal number of students in each program has been assumed. In the actual situation, the number of students in these central upper division courses will vary greatly with numbers in different programs and actual choice of options. Therefore, this final addition of courses would be quite dependent on the actual enrollment figures and other factors including non-formal audiences off campus.

Table II-4

Courses Added to Television When Enrollment
Limit is Reduced from 300 to 200 Students

Modern Languages English 206
Modern Languages French 202
Sociology 305 and 401
Chemistry 100 and 351
Mathematics 313, 407, 410, 414 and 441
Physics 100, 104, 304 and 418
Biology 100
Civil Engineering 331 and 421
Electrical Engineering 471
Mechanical Engineering 321, 323, 442, 451, 463, 481, 524 and 587
Material Science 240, 437 and 505
Psychology 207
Business 101, 201 and 202
Economics 301, 302, 303, 311 and 312
Geology 100, Education 240

Table II-5 lists all the courses that would be offered over the television if the student limit was set at 200 students. The course numbers enclosed in brackets indicate those courses with student enrollment falling between 200 and 300 in the case studied. Courses like these would be included in a television system with at least 200 students per course though the actual selection might vary with enrollment in different programs and selection of optional courses. The courses not in brackets are not as subject to such variations since they are mostly required by several programs or in some cases by all programs.

Table II-5

Total Television Courses with More Than 200 Students
( ) Indicates Between 200 and 300 Students in the Course

Persian 101 and 102

Modern Language English 101, 102, 201, 202 and (206)

Modern Language French (202)

Sociology 201, 202, 203, (305 and 401)

Chemistry 105, 106, 221, 222, 341, (100 and 351)

Mathematics 101, 102, 103, 104, 105, 106, 202, 205, 308, 309, (313, 407, 410, 414 and 441)

Physics 103, 105, 106, 107, 326, 432, 441, (100, 104, 304 and 418)

History 101 and 102

Biology 101, 102 and (100)

Civil Engineering 221, 222, 323, (331 and 421)

Electrical Engineering 222, 282 and (471)

Mechanical Engineering 341, (321, 323, 442, 451, 463, 481, 524 and 587)

Material Science (240, 437 and 505)

Psychology 203 and (207)

Business (101, 201 and 202)

Economics 201, 202, (301, 302, 303, 311 and 312)

Geology (101)

Education (240)

As the student enrollment is increased and television added, the facilities and the staff requirements change. The rate of change depends on the criteria for adding courses to television. If no television is used, the faculty increase will be closely proportional to the student increase shown in Table II-6.

Table II-6

Student Enrollment Per Year

Year	Students Enrolled
1	2,920
2	4,280
3	5,640
4	7,000
5	8,280
6	8,760

When television is added just for the lecture courses with enrollments over 500 students, the year-by-year needs are as shown in Table II-7. The total faculty requirements with this case still increases sharply over the six year period. Note that faculty and mentors are given as equivalent full time faculty. In most cases, faculty will have a variety of teaching assignments that may extend over several types of courses with fractional time assigned to each.

Table II-8 shows the staff and facilities needs when courses with enrollments greater than 200 are included on television. The courses added in this example extend up into the third, fourth and fifth years and thus, are added later in the growth as the increased student enrollments begins to effect the more advanced courses.

Even though the student enrollment has tripled in the entering class in only two years, the faculty expansion in this example is very smooth, increasing just over 10% per year. The balance comes mainly from television lecture courses freeing faculty to meet the rapidly growing needs in laboratory courses.

Table II-7

Needs by Year with Television Course Enrollment >500 Students

Year	1	2	3	4	5	6
Television Courses (hrs/wk)	0	21	42	48	48	48
Lecture Courses (hrs/wk)	436	415	394	388	388	388
Television Lecture Faculty	0	2	4	4	4	4
Lecture Faculty	136	131	123	167	212	234
Total Faculty for Lectures & TV	136	133	127	177	216	238
Mentors for TV & Lectures	24	40	53	63	71	74
Laboratory Faculty	43	72	100	118	132	136
Seminar Faculty	0.5	0.5	0.5	0.5	0.5	0.5
Project Faculty	5	5	5	5	5	15
Total all Faculty and Mentors	208	250	286	350	424	464
Lecture Rooms (hrs/wk)	958	924	874	1177	1496	1622
Laboratory Rooms (hrs/wk)	1088	1782	2456	2870	3180	3275
TV Discussion Rooms (hrs/wk)	0	206	378	408	410	410

For contrast, the needs in the sixth year with no television is shown in the last column of Table 8 on the following page. The introduction of television lectures reduces staff needs from 631 to 367. Total lecture and meeting room needs are reduced from 2,874 room hours per week to 1,544 room hours per week. Laboratory needs remain the same.

Table II-8

Needs by Year with Television Course Enrollment >200 Students

Year	1	2	3	4	5	6	No TV
Television Course (hrs/wk)	0	38	77	101	127	142	(0)
Lecture Courses (hrs/wk)	436	398	359	335	309	294	(436)
Television Lecture Faculty	0	3	7	9	11	12	(0)
Lecture Faculty	136	110	82	105	119	127	(408)
Total Faculty for Lectures & TV	136	113	89	114	130	139	(408)
Mentors for TV & Lectures	24	40	54	64	73	76	(72)
Laboratory Faculty	43	72	101	118	132	136	(136)
Seminar Faculty	0.5	0.5	0.5	0.5	0.5	0.5	(0.5)
Project Faculty	5	5	5	5	5	5	(15)
Total all Faculty and Mentors	208	231	249	302	340	367	(631)
Lecture Rooms (hrs/wk)	958	783	592	754	863	890	(2874)
Laboratory Rooms (hrs/wk)	1088	1782	2456	2870	3180	3275	(3275)
TV Discussion Rooms (hrs/wk)	0	253	472	549	612	654	(0)

E. OTHER CASES

The results just discussed were derived for the curriculum of Pahlavi University's Schools of Engineering and Arts and Sciences. The enrollment assumed started at 2,920 and rose rapidly to 8,760. The staff and facilities savings were dependent on the number of students and on the characteristics of the curriculum. It is of interest to see what the results are for different curricula and different numbers of students. For any particular application it would be appropriate to define the curriculum and run the planning program for the projected enrollments. It is possible, however, to describe with reasonable accuracy what the results would be for some typical cases. These are discussed below.

1. Full University Curriculum

The full Pahlavi curriculum has about twice as many degree programs as studied above and twice as many students in the current year. For television courses restricted to the assumed four channels, the minimum number of students per course would have to be raised to about 300 before it is televised. The list of courses would be about the same as given in Table II-3 but there would be a number of additional intermediate year courses added from the other schools to make up the total courses that could be fit in four classrooms.

Many lower division courses would have twice as many students because they are required in the other schools as well.

Because of these factors, all courses offered over four television channels would have from 50 to 100 percent more students. The savings in faculty and facility space due to these courses would have similar increases in comparison to the case studied.

The increased curriculum may well call for a fifth or sixth channel to carry additional courses that have enrollments nearing 200 students from the other schools.

The Pahlavi University would thus show even greater savings from the addition of television than the schools of Arts and Sciences and Enginee ing analyzed above.

2. Larger Enrollment in General Curriculum

With a curriculum about as complex as that studied but with more students, the benefits will increase accordingly. If enrollment started at 6,000 and increased to 18,000, for example, all lecture courses on television will have about doubled enrollment. One or two additional channels would be warranted to add courses that exceed 200 students.

The reductions in faculty over what would be required without television will also increase greatly, reducing the faculty to about one-half that needed without television. As before, the limiting factor is the need for faculty in courses that are not televised, e.g., laboratories.

3. Specialized Curriculum Fully Televised

There are very critical needs in Iran for graduates in particula occupations. Teacher education is one area of particular importance since the supply of teachers for elementary or secondary schools has not been able to keep pace with the growing number of school age children. Using television in all years of a teacher training college program would be a way of rapidly expanding the graduations.

If a focussed program is carried out, the course requirements could be kept within one or two channels of television. The benefits of television would depend on the fraction of normal lecture to laboratory and workshop courses.

With a full curriculum on television and enrollment expanding from 2,000 to 6,000 students, the savings in staff required for the lectures would be about 3 or 4 to 1, i.e., one-third to one quarter the faculty would be needed. In addition, a high percentage of the faculty needed would be mentors for the television courses. These would require less training than the equivalent normal lecture faculty.

The total savings will depend on the ratio of workshop and laboratory to lecture courses. With a mix close to that of Pahlavi University's, the reductions in faculty needs including laboratory or workshop acitivties would still be well over half.

Study of the teacher training curriculum in detail should be done using the planning program to determine the best mix of television and normal courses. This review would have to consider the teacher motivation and the demand for education as well as the faculty and staff limitations analyzed by the program.

The teacher training programs would also have a potentially large external part-time audience in in-service training that should be included in the analyses.

The computer program presented can be applied directly to any of the above cases for any institution that wishes to assess the impact of television on its operations.

APPENDIX A

Appendix A is Chapter III of the report entitled Program Planning Assistance, Vol. I submitted to NIRT August 1975.

EDUCATIONAL TELEVISION USE IN THE UNITED STATES AND GREAT BRITAIN: AN OVERVIEW AND CASE STUDY ANALYSES

A. INTRODUCTION

Chapter II examined Iran's needs for trained manpower and the short time available to meet those needs, showing that there must be a major effort to develop skilled manpower if Iran is to achieve its goals. This chapter examines the manner in which educational television (ETV) can be used to foster more rapid development of a skilled work force. Specifically, three major effects of ETV are examined:

- The total number of students who can be managed by one instructional staff member with ETV, either principal instructor or mentor. Mentors are less highly trained members of the instructional staff who interact with students.
- The effectiveness of ETV in allowing mentors to assume the role of in-class instructor.
- The efficiency of ETV in increasing the accessibility of education to students in outlying geographic areas and/or to others who are unable to acquire an education in the traditional setting.

There is sufficient information in the literature to describe these effects at the elementary and secondary levels. However, the published data on the use of ETV with mature students at the advanced secondary or the postsecondary levels are inadequate. It was, therefore, necessary to conduct a survey of such use and relate the results to the Iranian situation.

Seven cases from the United States and Great Britain were chosen for study: Chicago TV College, Stanford University's Engineering Telecourses, the Association for Continuing Education, Outreach Consortium, Coast Community College District, Oregon State University, and the British Open University. Each of these uses ETV to substitute for live lectures to mature audiences. They include postsecondary degree programs, special subject-oriented programs and vocational training. In all cases, the ETV is one component of a total instructional program which includes supporting printed material and also provides for direct student interaction with a teacher or mentor.

The remainder of this chapter is organized as follows:

- Section B presents the major conclusions reached as a result of the case study analyses.
- Section C cites a number of examples of how ETV has been successfully applied, noting that the more efficient uses, in terms of training large numbers of people, occur at the adult level.
- Section D provides a description of each case study in terms of its educational objective in using ETV and an analysis of its success in meeting that objective.
- Appendix 3A presents a series of tables which contain the detailed information obtained from each case study.

B. CONCLUSIONS

This section presents conclusions based on a general review of ETV uses and on an analysis of the use of ETV in the seven case studies. The next section provides descriptions of each study with further detail included in Appendix 3A.

The major conclusions are as follows:

1. The most effective use of ETV for massive manpower training programs is as a replacement for live lectures to mature students.

   - Use of ETV at the elementary and lower secondary levels, such as at Hagerstown, Maryland, and Anaheim, California, provides gains of about 33 percent in increasing the number of students which can be taught by the instructional staff. This gain is small by comparison with what can be achieved with adult students, and reflects the need to maintain low student-teacher ratios with less mature students.

- At the postsecondary level, the case studies show that ETV permits doubling, and in some cases tripling, the number of students who can be taught by a given size instructional staff.
- By using less highly trained people as "mentors" for local interaction with the student, even greater expansion is possible for a given size academically-qualified staff. As many as 22 mentors have been used with a principal instructor, each serving 30 students (see Conclusion 3). This is not feasible for younger students.

2. ETV increases the total number of students that one principal instructor or mentor can handle.

Examples include:

- In the case of Chicago TV College, a half-time instructor normally is limited to 70 students. With ETV, a single instructor was responsible on a half-time basis for 210 students in one course, a factor of three increase. In another course the increase was from a full-time instruction load of 140 to 550, a factor of four.
- In the Coast Community College District, the number of students handled by a single instructor ranged from 150 to 600 in contrast to the average student-teacher ratio of 30:1. While supported by clerical assistants, the instructor was responsible for all content-related discussions with students.

The importance of these examples is that Iran, hampered in manpower training by lack of instructional staff, can reach more students with ETV than without.

3. ETV allows the use of less highly trained instructional staff for student interaction.

   - With Coast Community College District's ETV courseware, the user institution has a range of choices in how the instructional staff will interact with students. One user of a psychology course, for example, made the principal instructor responsible for 600 students supported by a clerical staff and computerized grading. The principal instructor was available for telephone conferencing on content-related issues, with the clerical staff responsible for answering process-related issues. In another instance of a free-hand sketching course, a noncredentialed staff was to review, grade and comment on the student's work, under the principal instructor's guidance for an enrollment of 150 students.

   - In the case of Oregon State University, one principal instructor, assisted by 22 teaching assistants at the advanced undergraduate or Bachelor's degree level, managed an enrollment of 700 in a biology course. The teaching assistants met with groups of 30 students for one hour per week in recitation.

These examples lead to the conclusion that, with ETV, Iran could use less highly trained mentors to interact with students. This is important because there are far more people qualified to be mentors than there are to be college or university faculty.

4. ETV principal instructors can be drawn from non-academic institutions.

   - The Association for Continuing Education uses off-campus experts drawn from high technology government and industrial laboratories and from consulting organizations.

Chapter II shows the shortage of manpower in the professional and technical categories. The small number of highly trained people in these categories should be utilized to the fullest as principal instructors. For those not members of college or university faculties, ETV provides a way for them to contribute their talents with a minimum disruption to their main work. This is possible because the course design and TV production work can be scheduled to meet the needs of the principal instructor more easily than the scheduling of a conventional class.

5. ETV is effective in reaching students at remote locations.

- The Chicago TV College has awarded a total of 400 AA (Associate of Arts) degrees to students taking all coursework via ETV; 75 percent of these students have been incarcerates in penal institutions. The college also has an annual enrollment of 9,000 overseas servicemen in academic and vocational training. The requirements for the degrees are the same as for on-campus students.
- The Coast Community College District conducted a post-course survey which revealed that 50 percent of the students would have been unable to take courses in the traditional setting. Courseware includes introductory postsecondary courses and general courses, such as sewing.
- Stanford University's Engineering telecourses were taken by 2,029 students in 1972-73, the majority of whom were full-time employees of the local industry users.
- British Open University's records indicated that only 2.5 percent of its students in 1974 were unemployed or retired and that 13.7 percent were housewives. Hence, BOU is reaching people with less chance to attend

traditional education institutions. In addition, the Open University reached some 210 students in institutions.

- Oregon State University transmits its telecourses to an annual on-campus enrollment of 8,500, 70 percent of whom view the ETV lectures off campus, and attend recitation and laboratory sessions on campus.

This conclusion establishes a critical point for Iran: that people in inaccessible areas can be effectively reached by ETV. Combined with the ability to use less highly trained people as mentors, this provides the basis for an effective remote area education system of great importance for Iran's rural population.

More generally, the role of ETV can be seen as permitting the expansion of education by having larger student-mentor ratios and by having the principal instructor manage a group of mentors in the remote locations.

C. APPLICATIONS OF ETV

This section presents a brief overview of how ETV has been successfully used in a range of applications at the elementary and secondary, vocational and technical training, and postsecondary levels. These applications are examined from the perspective of efficiency in reaching large numbers of students.

Elementary and Secondary examples include:

- Washington County (Hagerstown), Maryland. This system has been in operation for 21 years and broadcasts 41 courses weekly to elementary and secondary schools with a total enrollment of 23,000 [1].
- Anaheim, California has had an ETV system in operation for 18 years. The school district is providing 144 separate programs per week. For students in kindergarten through 8th grade, 12 to 20 percent of their class time is spent with ETV [2].

- Santa Ana, California has been operating an ETV system for 14 years. It provides broadcasts for over 31,000 students at every grade level in elementary and secondary schools. In 1972 there were 133 telecasts per week to the elementary schools alone [3].

Vocational and Technical examples include:

- The State of Utah began broadcasting the first of a series of vocational education courses over the state educational television network in October 1972. There were 60 programs of 30 to 40 minutes duration, constituting nearly 50 percent of the course time [4].
- An example of ETV use in technical areas is to be found in the RCA company program for instruction. Every RCA plant in the U.S. has some local university connection. Television programs are shown typically in twelve two-hour sessions, and an associate instructor is with the class to handle discussions and to monitor progress. Study guides are prepared for the courses and include still frames from the televised material [5].
- ETV has been used for upgrading technical training of employed workers in Poland, and in secondary-level technical courses in Japan [6].

Post Secondary examples include:

- Stanford University, the University of South Carolina, Case Western Reserve University, Colorado State University, Cornell University and the University of Florida, among others, have successfully provided graduate and post graduate courses via ETV to off-campus industrial locations [7].

- The British Open University and the Bavarian Telekolleg are examples of successful programs based on providing college level material through televised lessons [8, 9].
- ETV has been used for continuing the medical education of physicians in the Soviet Union [6].
- Teacher training via ETV has apparently been successful in Algeria, Colombia, New Zealand, and elsewhere [10].
- Adult literacy and education has been dealt with in Niger and Italy using ETV [10].

The effectiveness of ETV in these various applications has been examined in a number of surveys and evaluations. Comprehensive assessments by Chu and Schramm [11], Reid and McLennan [12], and Jamison, Suppes and Wells [13] all agree on one main point: ETV, when properly used, is as good or better than conventional instruction. However, in assessing the ETV uses which will potentially provide the most benefit to Iran, it is necessary to determine which are most related to Iran's need for a rapid increase in skilled manpower. Therefore, the following considerations are noted:

- Results from Anaheim and Santa Ana ETV use are representative of the elementary level. They show a one-third increase in the number of students that each regular teacher could teach. The savings were achieved by combining large classes. For Iran this is not appropriate for half its population, considering the low rural population densities and small class sizes.

  The increase in students per teacher is estimated as follows: In Anaheim and Santa Ana the fifth and sixth grades spend half a day in their home rooms with one teacher for each 25 students. The other half of the day is spent in an "audio-visual resource room" with four classes totalling 100 students directed by two teachers and a teacher aide. The two grade levels share the same teachers and classrooms. When one grade is in the resource room, the other grade is using the individual classrooms. They exchange places halfway through the day. Therefore, six teachers and one aide handle 200 students. Counting only the regular teachers, the student-teacher ratio increases by one third to 33.3.

- On the other hand, Chicago TV College experienced a 400 percent increase in the number of students handled by one teacher in an ETV Child Development Class, and Coast Community College District cited one case where a single instructor managed an enrollment of 600 ETV students in a televised psychology course.

- In addition to increasing the number of students per instructor, the issue of reaching off-campus locations is important. Colorado State University, for example, reached 1,450 students in 31 off-campus locations during 1973-74, an enrollment which was larger than that on-campus. Similarly, Southern Western University reached 635 students off-campus in seven remote sites in comparison to the 665 students enrolled in undergraduate and graduate courses.

In view of Iran's need for a rapid increase in the numbers of skilled workers, the issue of how ETV can most efficiently extend the ability of existing trained manpower towards meeting this goal is crucial. Since the increase in number of students per teacher with ETV is less at the elementary than the adult levels, i.e., 14-15 percent vs. up to 400 percent, this study was focused on the use of ETV to deliver lecture material to adults. The additional ability of ETV to extend technical and professional skill upgrading to remote employment locations further reinforced this judgment.

D. CASE STUDY ANALYSES

This section describes the functional application of ETV in seven educational systems within the United States and Great Britain. In each case, the objective of ETV use is noted, and variations among the system are described in terms of:

- Qualifications of the instructional staff.
- Efficiency of ETV in increasing the number of students per principal instructor.
- Accessibility of education via ETV to those unable to attend traditional institutions.
- Effectiveness of ETV use in meeting the stated goal.

Quantitative data of the type needed for this analysis was either imprecise or lacking in recently-published literature. Therefore, the information gathering was accomplished by telephone interviews and, in two cases, by on-site visits. Case study data are summarized in Table 3-1.

1. Chicago TV College

An extension of the state and locally-supported Community College District of Chicago's (Illinois) seven campuses, the TV College was started in 1956 with the intent of bringing the opportunity for postsecondary education leading to an AA degree to those who were unable to receive it in the traditional manner [14]. The course offerings, which included teacher training and renewal courses, have since been expanded to include electives and, more recently, vocational courses. The latter is a result of a legislative mandate which allows the community colleges to depart from purely academic instruction in order to include vocational training in such subjects as secretarial skills, and business law. The college rents space for production and delivery from station WTTW, an open circuit educational television station.

TABLE 3-1

Summary of ETV Use Data

	Chicago TV College	Coast Community College District	Outreach Consortium[3]	Stanford Univ. Engineering Telecourse	Association for Continuing Education	Oregon State University	British Open University
Academic Qualifications of ETV Instructor	B.A. to Ph.D. (60% Ph.D.)	B.A. to Ph.D. or non-academic	Experts from ed., business, gov't and medicine	Ph.D.	Experts from ed., gov't, bus., and consulting groups	Ph.D.	B.A./B.S. to Ph.D.
Academic Qualifications of Mentor	Mentors precluded by union regulations	TAs with B.A. or trained clerical staff	N.A.	Generally not used	Mentors not used	B.A./B.S. or advanced undergraduate	Minimum of B.A./B.S.
Number of Students per Principal Instructor Using ETV	210 to 550	150 to 600	Institution estimates 1,000	Total number of remote sites:36	10 (limit of 40 set by ACE)	700	N.A.
Number of Students per Mentor Using ETV	—	150[1]	N.A.	—	—	30:1	12:1 to 20:1 maximum
Total ETV Used	90 hrs/semester (repeated twice per week)	75-90 hrs/semester	15-hr. course	1,200 hrs/quarter	457 hrs/quarter	600 hrs/quarter on courses; 660 hrs. other uses[4]	37.5 hrs/week (equivalent of 450 hrs/quarter)
Principal Instructor's Time:							
• Preparing to Use ETV Course	0 (principal instructor is ETV instructor)	0 to 2 hrs/class hour	N.A. (self contained; could be 0)	Live lecture	Live lecture (initial preparation to use ETV: 5-8 hours)	0 (principal instructor is ETV instructor)	Principal instructor is ETV instructor
• With ETV Students	7.2 to 23.5 hrs/week	2-3 hrs/week[2] to 10 hrs/wk	N.A.	2-way audio feedback;minimal time outside class	2-way audio feedback; minimal time outside class	7 hrs/week	During summer school
• With Mentors	—	N.A.	N.A.	—	—	2 hrs/week	—
Mentor's Time:							
• Preparing to Use ETV	—	N.A.	N.A.	—	—	2 hrs/class hour	N.A.
• With Students	—	N.A.	N.A.	—	—	2 hrs/week	22.5-27 hrs/week maximum

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[1] In this case, the mentor role may be filled by associate professors in the user institution responsible to the department head (principal instructor), or by a course facilitator on the clerical staff (see text).

[2] Lower bound based on case where total reliance is placed on ETV course and instructor/student interaction occurs over weekly telephone conference hours; upper bound based on case where supplementary recitation and discussion classes are held.

[3] This course was released in September 1975.

[4] Special services such as recording expensive laboratory experiments and training TV instructors.

Students registering for a course from the TV College have the option of taking it on one of the District's campuses or at an off-campus site (e.g., home, penal institutions, etc.). Of the 2,300 enrolled during the spring 1975 quarter, approximately 70-80 percent were off-campus viewers having no contact with community college activities. A summary of the Chicago case study is presented in Appendix 3A, Table 3A-1 (page I-107) while the major variations are described below.

a. Qualifications

Although approximately 60 percent of the TV College instructors hold a Ph.D. degree, a major criterion for selecting the ETV instructor is ability to effectively present the course over television. Thus, instructors at the Bachelor's or Master's degree level may serve as principal instructor in contrast to the more traditional reliance on Ph.D's.

In the Chicago case, strict teacher union regulations stipulate that a qualified instructor must be the primary contact for the student and therefore the use of teaching assistants is precluded. Either the principal instructor handles an entire ETV course enrollment, or individual sections are managed by an instructor with at least a BA/BS degree.

b. Efficiency

Again, due to union regulations, an instructor on one of the District's seven campuses is limited to a total of 140 students per semester and 15 hours of instruction per week [15]. However, special union rules apply to the television instructors. Thus, in the example of a Child Development course, the ETV instructor handled a total enrollment of 550, an increase of 400 percent. This capability for increasing the number of students per principal instructor can, in this case, be attributed to a number of factors:

- Only 20 percent of the students enrolled in Child Development attended the optional teacher-student conferences at the city's three learning centers. This is the average number of students enrolled in any of the TV College's courses who seek out active involvement with the instructors [15].

- Similarly, only 20 percent of the students used telephone conferencing time. Since the majority of these questions concerned process (e.g., exams, due dates, repeat course performances, etc.) rather than content, an informed member of the clerical staff could have responded [15].

- The TV instructor developed the course so that prolonged preparation time on a weekly basis was eliminated.

A second example serves to underscore the ability of ETV to increase the number of students handled by a single teacher. With a Spanish course that normally constituted half of her teaching load for the semester, the instructor had an enrollment of 210. Normally limited to 70 students in the traditional classroom for each of her two courses, she dealt with a 300 percent increase.

It is noted that students were required to meet with the teacher for seven recitation sessions in the learning centers. Thus, the instructor's involvement per student here was higher than for the 20 percent in the Child Development course where conferences were optional.

c. Accessibility

Several examples can be cited which demonstrate how the TV College extends the opportunity for postsecondary education to people who would otherwise be unable to receive it. These include:

- Studies Unlimited: A self-paced learning program administered by Learning Advisors in the public library system whereby a student views the course on tape, takes the exams, and completes assignments with no involvement with an instructor. This program serves the needs of those who cannot view the broadcast at the time it is offered, or who cannot maintain the pace of the course.

- Penal Institutions: A program whereby the course is administered by correctional officers and the TV instructor visits the prisoner/students once or twice a semester for lecture and discussion sessions.

- Gifted High School Students: A program whereby students combine TV instruction with credit earned in college exemption tests enabling them to earn up to a year's college credit while still in high school.

- Physically Handicapped and Hospitalized: A program whereby the course is administered by ministers, social workers and others working part-time. The college grades exams and performs other academic and administrative functions.

- U.S. Army Air Force and Army Servicemen in Germany: A course in Data Processing.

d. Effectiveness

The Dean of the TV College emphasizes that TV instruction alone cannot carry the entire teaching burden, and that it must be supplemented by printed study aids and text books. He also notes that face-to-face instructional activities are desirable. With the Studies Unlimited program, the students have not done as well as the average, for example. On the other hand, while only 20 percent of the TV students sought contact with the Child Development course instructor, the average retention rate was equal to that of the District's traditional community college classrooms (i.e., 65 percent), which is an indicator of the possible success of ETV courses.

In various evaluation-type studies undertaken by the TV College, results which have planning implications include:

- In addressing the quality-of-production question, the TV College imported a course costing approximately 10 times that of its own courses. Students enrolled in both were asked to compare and rate the two presentations. The results were mixed, with 75 percent of the responses giving a version of the following answer: "Give us a bit of both. Alternate the two types of presentation formats, either within a single program, or between programs in a series" [16].

- During the early years, the College imported nationally-recognized scholars to design and present ETV courses. In general, this was unsuccessful because local instructors were more familiar with styles, interests, and the academic needs of local student population.

- In the third year of operation, a study indicated that TV students generally fared better than their in-class counterparts [17]. While this may be attributable to maturity and motivation of the TV students, it is another indication of success.

A summary of indicators used to analyze the efficiency and effectiveness of the Chicago TV College and the results of that analysis are presented in Table A-2.

2. Coast Community College District

Coast Community College District, consisting of Orange Coast College and Golden West College, has been offering community college courses for credit since the spring semester of 1973. With the objective of bringing high quality ETV postsecondary instruction, the District owns and operates its own PBS-affiliated broadcasting station, KOCE, reaching not only the District's population of 450,000 but also another one million residents of Orange County, California [18].

Course offerings consist of introductory-type academic classes such as anthropology and psychology, and others of more general interest, such as free-hand sketching and vocation courses such as sewing. These courses are either produced at KOCE or imported from other educational institutions striving for the same high quality ETV material. The instructional packages accompanying the TV course include textbooks, study guides, and other supportive material designed to be sufficient for the student who cannot or will not seek consultation with the on-campus instructor. The District also exports their courses to other academic institutions. A summary of this case study is given in Table 3A-3 (see Appendix A).

a. Qualifications

In the Coast Community College District case, a differentiation is made between the ETV instructor and the instructors in the user-colleges. With high quality production as a key concern, the ETV instructor may or may not be an academic person. An actor may use material developed by the principal instructor to insure effectiveness of the TV presentation. In the two-year community colleges, the principal instructor is likely to hold either a Master's or Ph.D. degree, and in the four-year colleges and universities, a Ph.D.

Since the District designs courses for minimum reliance on the instructor, each academic user-institution has a choice on such issues as how, or if, student/instructor interaction will take place, or if teaching assistants or mentors will be used.

b. Efficiency

Given the various ways that a user institution may choose to use the District's ETV material, a number of examples can be presented to document the efficiency of their ETV courses. With the psychology course, for example, one instructor handled 600 students, representing a factor of 20 increase over the 30:1 ratio. This was accomplished with the support of a large clerical staff and computerized grading systems. On the other hand, another user institution with a total enrollment of 600 in the psychology course chose to divide the group into four sections of 150 students with four MA or Ph.D. instructors per section and with the principal instructor overseeing the program.

Another example is free-hand sketching, where two instructors handled an enrollment of 600 in one college, while another college chose to allocate the 600 students among four instructors. In the first case there was, therefore, a factor of 10 increase in the number of students handled by a single instructor and in the second case, a factor of five increase. In both situations there was a noncredentialed review staff who were trained to use predetermined formulas to grade and comment on the student's progress.

In the two District colleges, student interaction with the college is enhanced by a 24-hour recorded answering device on the telephone. Either the instructor or clerical staff returns calls, depending on whether the question is content- or process-oriented. (As with the Chicago TV College experience, the majority of calls are process-oriented.) In addition, the instructor schedules a minimum of two to three hours a week for telephone conferencing.

It is emphasized that the Coast Community College District's courses are packaged in such a way that the course can run the instructor, or vice versa. That is, the package is sufficiently self-contained that one user institution may choose to rely totally on it, with face-to-face contact occurring mainly during midterm and final exams, while another might choose to supplement the ETV with discussion and recitation sessions twice a week. Even in the latter case, the course's package contains discussion outlines so that further information is not necessarily required [18].

c. Accessibility

Of the TV student enrollment sampled following the spring 1974 quarter, 66 percent indicated that they enrolled in TV courses rather than traditional for convenience reasons. Of these, 50 percent indicated that there were reasons why they could not attend on-campus classes. Included in the student population surveyed were 38 percent who indicated they were housewives, and an additional 45 percent were currently employed. Thus, it would seem that the District is reaching students who desire postsecondary education but would not be able to attain it in the traditional setting. Indicators of the efficiency of the Coast Community College District's ETV courses are shown in Table 3A-4.

d. Effectiveness

The District attempted to evaluate the effectiveness of their ETV courses by soliciting student response both during and after its delivery [19]. The following are some results of that study:

- The overall completion rate, based on whether or not the student took the final exam, was 37.6 percent. However, since only 44 percent of the total enrollment indicated that credit towards a degree was the prime motivation for enrolling, the relatively low completion rate may be less significant. Thirty-four percent indicated that they were motivated by "general interest," 16 percent by "desire to advance professionally," and six percent by "other" motivation.

- Of the students who participated in the evaluation study by completing course diaries and questionnaires, 75 percent completed the course, which would indicate that some type of active involvement with the course in addition to coursework is desirable.

- Of the exam takers, 73 percent indicated that the TV course provided direct assistance to them, 90 percent indicated that they would recommend the course to others, and 91 percent replied that they would enroll in another TV course. Comparable figures for nontakers are 56, 86, and 89 percent respectively.

- Nearly all of the 73 students who completed a face-to-face interview endorsed the concept of a course facilitator on campus. However, less than 16 percent indicated that they had done so, and less than two percent of the entire spring TV student sample indicated that they had maintained frequent contact.

3. Outreach Consortium

The Outreach Consortium is comprised of 18 institutions of higher education in Orange and San Diego counties, California. It was formed in 1971 with funding from the Postsecondary Commission of California with the mandate to examine the state-of-the-art and potential for developing and offering broadcast courses. In developing this model consortium, research was carred out to determine what courses could be developed and offered by the member institutions to provide increased educational opportunities for the students in their service areas.

The first course, Contemporary California Issues, which addresses topics of current concern (poverty, crime and criminal justice, drug abuse, resources and energy, pollution, aging, racism, sexism and education) will be released in September 1975, and hence little can be said currently about course delivery. However, it is noted that Golden West College and Coast Community College, two of the 18 consortium members, are anticipating an enrollment of 6,700 or approximately 3,350 per campus. Current plans call for 1,000-plus students per class. In addition, the University of California at Irvine is intending to offer the course this fall and supplement it with lectures every other week by experts in the subject matter. This case study is summarized in Table 3A-5.

4. Stanford University's Engineering Telecourse

Stanford University has been offering post graduate engineering courses leading to MS, Engineer, or Ph.D. degrees over the Stanford Instructional Television Network to employees in the San Francisco Bay Area firms since 1969. These courses are offered to three types of students in 37 participating industries: (1) the Honors Cooperative Program (HCP) students who are enrolled for credit, (2) the nonregistered-option students who are not matriculated at Stanford but are tested and graded and have the option of matriculating and transfering credits earned if a course is successfully completed, and (3) auditing students who attend courses for a reduced fee but are not tested or graded.

The format of instruction is lecture in studio-classrooms, with on-campus students in attendance, telecast live with two-way audio feedback between the instructor and the on- and off-campus students. This case study is summarized in Table 3A-6.

a. Qualifications

The majority of television instructors are Ph.D.'s, with teaching assistants at the Bachelor level or higher used in the traditional capacity and not employed for the TV students per se [20]. An exception occurs when the TV course has been sent on videotape for showing outside of the university's network range. In this situation, one or two tutors at the industry site are selected by the Stanford instructor on the basis of having qualifications equivalent to a Stanford teaching assistant.

b. Efficiency

The efficiency question is straightforward in this case. As noted in Table 3A-7, the off-campus enrollments have grown from 154 in 1968-69 to 2,008 in 1973-74, with 150 engineering courses offered.

Communication aside form the direct audio feedback is maintained by a courier who delivers supplementary lecture notes and readings to the off-campus sites and returns exams and other assignments to Stanford. In addition, the HCP students have the option of conferring with the instructors although, in fact, very few do so [20]. They can also use campus facilities.

One point to be raised in assessing efficiency is the fact that since the instruction is live, the problem of updating existing ETV material is eliminated. Another issue relates to efficiency from the university's point of view. In Stanford's case, the full cost of educating the HCP students is effectively paid for by fees from the user companies. These funds were transferred to the departments where the students were studying which made it possible for the School of Engineering to hire 20 additional professors [21]. In the network manager's opinion, no additional instructor costs should be assigned to the ETV students because the audience for existing programs is merely expanded [20]; if viewed from this perspective, the university experienced a significant gain.

c. Accessibility

Since the expressed purpose of this program is to extent the opportunity for post graduate engineering courses to employed individuals in off-campus sites, the efficiency of meeting this goal is also straightforward. As noted in Table 3A-7, the number of remote sites has grown from 18 in 1968-69 to 36 in 1973-74.

In examining efficiency from the perspective of value to the remote sites, two types of savings are used as indicators: savings in student time, and savings in cost. In the first instance, savings can be calculated in terms of commute time which has been estimated as up to three hours of commute per class hour. In terms of cost, if the student uses these three hours in commute time, the employer might have the added cost of hiring additional manpower. Even if the employee-student pays his own way in the sense of becoming a part-time worker, the overhead cost of two people working half-time is greater than for one person full-time [22].

Two less tangible effects of off-campus study include (1) the motivation for other workers to review their basic education, provided by observing the student studying at the work site, and (2) the ability of participating companies to attract qualified employees by offering them the opportunity for postgraduate study [22].

A summary of indicators of the effectiveness of Stanford's ETV courses is given in Table 3A-7.

d. Effectiveness

One indicator of effectiveness of Stanford's program is the fact that 1,500, or 50 percent of those enrolled in the HCP program have received graduate degrees. Another indicator is the industry participation, which had increased 100 percent, from 18 to 36 users since 1969.

Finally, the fact that several existing videotape courses are now exported to Japan and to Hewlett-Packard in San Diego and Santa Rosa, California, attests to industry's perception of the effectiveness of the Stanford ETV courses.

5. Association for Continuing Education

In late 1969, it became apparent that the Stanford Instructional Television Network could be used to further serve the needs for postsecondary training of employees in the Bay Area's industries. The programming offered, with 77 percent in live transmission similar to the Stanford Engineering telecourses, includes: an MBA program through Golden State University, the Foundation Program for the MBA degree through the College of Notre Dame, a program for the MS degree in Cybernetics Systems Engineering through San Jose State College, and a number of special courses designed to meet specific education or training requirements of member firms.

The classes are offered at times when Stanford Engineering courses are not scheduled -- i.e., in the early morning, at noon, and in the early evening. This case study is summarized in Table 3A-8.

a. Qualifications

The instructors who appear on the live ETV programs range from MA's, MS's, and Ph.D.'s from educational institutions to off-campus experts drawn from Bay Area high technology government, and industrial laboratories and from consulting organizations. Teaching assistants, as such, are not used [23].

b. Efficiency

The Association sets a limit of 40 students per instructor in courses telecast live so that increase in the number of students per principal instructor is not an issue here. What is significant is the fact that the instructors are frequently regarded as part-time, serving as adjunct faculty with no full-time role at the college or university. In this sense, an expert from a consulting firm, for example, can be viewed as extending the teaching resources of the community, which is an efficient means of increasing the instructional pool and sharing the experience of a skilled working force with the students.

c. Accessibility

The mandate of the Association for Continuing Education is to meet the specified needs of the industrial sector by making education accessible to their employees. One example is a course designed for geologists at the Standard Oil Company, who requested a course in Global Techtonics. The course was comprised of 20 state-of-the-art lectures prepared by an expert in the subject from the School of Earth Sciences at Stanford University. Standard Oil videotaped this lecture series, and later distributed the program to geologists around the country and the world. In the 12-months period following the live telecast, over 700 geologists viewed these lectures [24].

Other examples of upgrading employee skills include the MBA program, effective business writing, which is designed to acquaint clerical help with technical language, and the Government Contracts Administration course [23].

d. Effectiveness

While the above example indicates how Standard Oil viewed the effectiveness of the Association's programming, another indicator is an increase of 74 percent in total enrollments and of 100 percent in industry users over a five-year period. Indicators of the efficiency and effectiveness of the Association's ETV courses are presented in Table 3A-9.

6. Oregon State University

Oregon State University began experimenting with various forms of televised instruction in 1954, with its first course offered over the state educational television network in 1957. At that time, a primary consideration was the rapidly expanding student population leading to overcrowded classroom facilities and large class sizes. In 1966, the university entered into a contractual agreement with the Corvalis Cable Company to provide at least 18 hours of instructional programming a week in exchange for exclusive use of Cable Channel 5 and no annual charges. Since 1967, an average of 30 to 45 hours of instructional programming have been presented each week, 95 percent of which is on videotape.

In addition to courses and traditional academic subjects such as psychology, biology, economics, and mathematics, short courses in computer programming, library orientation, and subjects of general community interest are presented. These courses are also telecast over the university's closed circuit TV network along with other films in the "special interest" category. The primary emphasis in all course and special interest offerings is to provide the faculty with ETV material which will enhance their instructional ability.

Oregon State University's use of ETV is summarized in Table 3A-10.

a. Qualifications

The university's ETV course instructor is most likely a Ph.D., although occasionally a recognized authority may be used in one of the course segments. Generally one student section for an ETV course is handled by the TV instructor and the other sections are under the direction of a teaching assistant or advanced undergraduate [25].

b. Efficiency

With the high percentage of teaching assistants used for student sections noted above, the extended ability of one principal instructor is clear. In one example of a biology telecourse, where the course enrollment was 700, the TV instruction was presented three times a week supplemented with a one-hour laboratory session and one-hour of recitation. In this instance, the TV instructor had his own section of students, and visited each teaching assistant's section once during the quarter. A student/instructor-teaching assistant ratio of 30:1 was maintained.

c. Accessibility

With the university being primarily faculty-oriented in the sense of meeting the needs of its own teaching staff, a number of examples can be cited for how the accessibility of ETV enhances the instructor's course presentation. It is noted that these present a departure from the previously-documented case studies in the sense that the students are registered at the university and are not an off-campus group (e.g., prisoners, handicapped, etc.). Examples of special applications include:

- Faculty self-evaluation by videotape recording, either in a private taping session or taped in class.
- Videotaping of TV lesson-demonstrations when it is difficult or expensive to continuously repeat a live laboratory experiment, for example.
- Videotaping of lectures by guest experts for use in future classes.
- Use of videotapes from other institutions.
- Videotaping of a class when the instructor plans to be absent from the campus.
- Videotaping of review and testing materials for student use prior to final exams.

In addition to the above, it is noted that the Speech and Communications Department uses Cable Channel 11 as a community training laboratory for student broadcast trainees. In 1973, these students produced about 120 hours of community programs involving local newscasts, public affairs, and campus entertainment, and an additional 45 hours of live sports cablecasts. The operations of Channel 11 are not further pursued in this case study.

d. Effectiveness

The measures for effectiveness in this case are less easily quantified than in the previous discussions. One positive indication of the university's success in meeting its goal to reach a large student population and to reduce class size is the fact that of 8,500 students enrolled in ETV courses each year, 70 percent view these off-campus, and on-campus sessions are held to a 30:1 student-instructor and/or teaching assistant ratio. Another positive indicator is the acceptance by the faculty of ETV, a point supported by the number of special applications demanded by the instructional staff and supplied by the ETV production staff.

Indicators of the efficiency and effectiveness of Oregon State University's ETV courses and special applications are given in Table 3A-11. In addition, there are the less tangible benefits of extending the experience of an expert via videotape to more than one class and the savings incurred by not repeating an expensive laboratory experiment, for example. There is insufficient data at this time to quantitatively measure these effects.

7. British Open University (BOU)

In operation since January 1971, the Open University is an exception to the other case studies in the sense that ETV comprises only a small part of a mixed media instructional package which also relies heavily on audio instruction, textbooks, self-assessment tests, student/tutor interaction, student/counselor interaction, and other supportive strategies. Recent estimates are that of the 15-17 hours per week that a student spends in coursework, between 2.5 and 2.8 percent is devoted to watching the ETV program [26]. However, since the planning and design team for courses is comprised of faculty, the ETV staff and others, with the entire team required to approve each component, the ETV side of it is obviously considered important and will be viewed as such for the purposes of this discussion.

In total, some 37.5 hours per week of ETV material are supplied over the nationally-owned BBC in the schools of Technology, Mathematics, Science, Education, Social Science and Humanities. This case study is summarized in Table 3A-12.

a. Qualifications

The academic qualifications of the Open University's instructors range from a BS/BA with recognized authority in the subject matter to a Ph.D. It is noted that this range of degrees is possible in Great Britain where less emphasis is placed on the importance of the Ph.D. per se [27] than in the United States. The part time tutors and counselors are mainly drawn from the instructional staff of traditional educational institutions and hold at least a Bachelor's degree. The same holds true for the full time tutors.

b. Efficiency

Interaction between the students and the instructional staff is unique in this case. The academic staff, totaling approximately 400 is allocated between the campus at Walton Hall and the 13 regions, 10 of which are in England and one each in Scotland, Northern Ireland, and Wales [28,29]. In addition, there are full time staff tutors and senior counselors in each regional office who are responsible for recruiting and training the part time tutors and counselors, the student's primary face-to-face contact with the university. As of 1973 there were some 5,100 part time tutoring and counseling posts filled by 4,600 people. The stated goal is for one tutor/counselor to handle a maximum of 12 foundation-level students, and for higher-level students, one tutor and one counselor per 20 students [29]. With regard to the higher-level students, the intent is to reduce the tutor and counselor load to a maximum of 16 students by 1976 [29].

With such an intricate educational system, it is difficult to represent the role of ETV in quantitative terms. The Institute of Educational Technology, the Open University's research arm, is currently engaged in a research project to evaluate the use of radio and television [29]. Even with the present data, however, it is clear that the Open University is moving away from high student-tutor ratios, which are important for the rapid expansion of training in Iran.

c. Accessibility

Virtually all of the ETV material produced to date has been prepared to support specific units in a course. This ETV material can serve three learning functions: (1) demonstrations of instruction, (2) description of case study material, and (3) presentation of imaginative insight. The science faculty, for example, uses ETV to present demonstration of the practical aspects of the course work, while the arts faculty concentrates on presenting the dramatic and creative experience.

In regard to making higher education accessible to those who would otherwise be unable to acquire it, the university's record speaks for itself. For example, of the total 1974 registered enrollment, 13.7 percent were housewives, 30.3 percent were teachers, and an additional 52.7 percent were employed or in the Armed Forces. In addition, 1973 registered enrollments included 29.3 percent of those having terminated their education by age 16. It can be assumed that these individuals would be unable to register in the traditional higher educational system.

d. Effectiveness

Here the issue is twofold: effectiveness of the total course and effectiveness of the ETV portion of that course. In the first instance, an indicator is the number of students who received credit which ranged from 75-92 percent in 1971, for example. The highest rate of examination success was in the arts, with 5,318 students taking the final examination and 5,232 receiving credit or approximately 98 percent. Similar percentages for examination success in 1971 for mathematics, science and social sciences are 82, 91 and 97 percent respectively. In 1973, the record indicates that 3,603 students graduated and 45,602 took final examinations in 49 courses resulting in the award of 45,201 credits [29].

Turning to the ETV portion of the course, an indicator of its effectiveness is the fact that between 85 and 98 percent of the students follow the ETV programming. Another indicator is that the science faculty has advised students who cannot receive the ETV programs not to enroll in their courses [28].

References (Appendix A)

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APPENDIX B

Appendix B is Chapter V (pages I-171 through I-180 and pages I-203 through I-218) of the report entitled Program Planning Assistance submitted to NIRT August 1975.

ETV DESIGN AND PRODUCTION

A. INTRODUCTION

The purpose of this chapter is twofold:

- Assess the personnel, time and cost involved in the design and production of ETV programming.
- Assess production needs for Iran and develop guidelines for the design and production process, including internal production and contracting to producers in other nations.

Because of poor documentation in the literature of what is required in the design and production process, this assessment is based on detailed statements obtained from each of the seven institutions in the course of the survey described in Chapter III. The range of studio times found in this survey is then used in combination with estimates of the volume of programming of a functioning ETV system to estimate the possible range in the number of studios required to meet Iran's needs. Comparing this estimate to present and planned NIRT ETV production facilities provides the basis for setting guidelines on how much capacity NIRT should have and how contract production should be organized.

The major conclusions are stated in the next section. Succeeding sections present results of the case studies and the assessment of production needs. Detailed information from the survey is tabulated in

B. CONCLUSIONS

The following conclusions were reached on the basis of the information from the case studies and the assessment of production needs for Iran:

- The number of people required to design and produce ETV programming, and the cost of that programming, is a strong function of the objectives of the system and its setting:

  - The number of people varies from as few as five production people plus two faculty members producing 58 hours of programming per year (Oregon State University) to 134 people (17 in production) involved in the production of a single series of 15 hours over a two-year period (Outreach Consortium).
  - The cost of studio productions varies considerably, from under $4,000 per hour at Chicago to $90,000 per hour at Coast. The cost does not correlate with effectiveness, since Chicago has a 65%-80% retention rate compared to Coast's 35%. However, what is needed for effectiveness varies with objectives and setting of the program.

- Large production volumes on the order of tens of thousands of hours are needed by Iran for postsecondary, vocational, in-service and adult education.

- If Iran is to fully capitalize on the mass training potential of ETV, it must have rapid buildup of a programming inventory. The peak rate of production would normally exceed what is needed in continuous operation of an ETV system so part of the initial production could be contracted out and Iranian production facilities expanded to meet only continuous needs, thus avoiding a future surplus capacity. The contracting can also be used as a means of training NIRT production teams by having key team members serve apprenticeships with the contractor.

- The design and production process can be useful to other developing nations. The mechanism for cooperation in the development of programming will have to vary from country to country. Iran should insure that it maintains rights to the educational package that is developed and then decide on a case-by-case basis whether to sell the package or use it as a form of aid. The salable portion may be limited to intermediate products of video content and support materials, leaving video format production to the recipient nation.

C. CASE STUDY DESCRIPTIONS: ETV COURSE DESIGN AND PRODUCTION

This section describes results of the seven case studies in terms of how each institution designs and produces ETV courses. A summary of results, provided by telephone interviews, on-site visits of two institutions, and published data is given in Table 5-1. Detailed information for individual case studies is presented in Tables 5A-1 to 5A-7, in Appendix 5A, with the appropriate references noted.

TABLE B-1

Summary of ETV Production Data

	Oregon State	Coast Community	Outreach Consortium	Chicago TV College	Stanford Engineering	Association For Contin'g Education	Open University
Personnel Required per Course for Planning & Design							
. Faculty	2	15	75	6		1	20-30
. TV Experts	2	1	4	1	1	1	
. Other	-	8	42	-	1	3	
Personnel Required per Course for Production							
. Faculty	1	1	5	1	1	1	N.A.
. TV Experts	3	17	17	5	1	1	
. Other	-	4	Not Avail.(N.A.)	-	2	2	
Total Studio Production Staff	5 (plus students)	60	60	N.A.	2 Full-Time 35 Part-Time	3 Full-Time 35 Part-Time	60
Studio Hours Required per Produced Hour ETV Material	2	15	15	3	Live Lecture	Live Lecture	N.A.
Time Required to Plan and Produce One Course	2 Yrs. Plan.; 4-6 Weeks, Design & Prod.	2 Years	2 Years	8 Months	-	2.5 Weeks to 9 Months	6 Mos. to 1 Yr.
Cost per Produced Hr. ETV Material (1975 Dollars)	$933-$6,666	$60,000-$90,000	$90,000	$3,572-$7,622	$118	$141	$2,400
Total ETV Produced per Year	58 Hrs/1974	30 Hrs/1975 45 Hrs/1976	15 Hrs/ 2 Yrs	112.5-135 Hrs/Yr	4,230 Hrs/Yr	1,600 Hrs/Yr (77% Live)	125 Hrs/Yr

The seven cases represent a wide range of practice, with major differences in the number of people involved in design and in the cost of video production. There is, in particular, one approach — the live studio classroom — which should be distinguished as basically different in concept from studio production. With the live studio classroom, the professor teaches a regular class and cameras in the room pick up the lecture for live broadcast to remote locations. There may even be audio feedback from the remote classrooms to enable the students at the remote sites to ask questions. This approach is the lowest cost of any, and allows for easy modification each time it is offered. It has the drawbacks that scheduling of live telecasts is almost impossible for large numbers of students over wide geographic areas, and the course has to be televised new each year. It is possible to tape a live classroom, as one of the seven institutions presented here does, but the approach would have to be tested in a new setting such as is found in Iran. If there is sufficient incentive, e.g., job advancement, then the lack of special effects and costly formats may not be important.

The important point to be raised about the live studio classroom is that it provides a means, at least for work-oriented courses and highly motivated students, to implement ETV services quickly. With the right support in terms of local mentors and printed materials, it may be possible to shorten the start-up time for ETV in Iran considerably, and at much less cost, if a number of courses use the live studio classroom concept.

As indicated in the discussion of Chapter III, Stanford University and the Association for Continuing Education (ACE) are the two institutions which use live studio classrooms. ACE uses taped sessions for some 27 percent of its broadcasts, and Stanford prepares some taped sessions for special industrial needs. The other five institutions all use taped studio productions for their courses.

1. Design of ETV Courses

Three elements of design are examined here:

- key personnel required in this phase;
- time required for course production;
- relationship between the design of ETV courses and the institutional setting.

a. Key Personnel

The number of personnel required in this phase and the degree of their involvement showed a wide variation in the case studies. In the Chicago TV College case, for example, the dean of that college decides that a particular course should be offered and solicits the assistance of faculty members from the appropriate departments of the other city colleges in the district with four or five attending the planning sessions. The ETV instructor is generally chosen from among these faculty representatives and is then responsible for designing the course content, assisted by a graphics expert to design the supplementary printed material.

In Oregon State University, faculty in the various departments hold regular planning sessions to determine which courses have a sufficiently large enrollment to justify a televised presentation, if presentation of these courses could be more effective on ETV, and which courses currently presented on television require updating or revision. When the decision is made to develop or revise an ETV course, the ETV personnel are brought in and an instructor selected who is subsequently responsible for developing or revising the course. In this case, assistance in preparing graphic material for the on-film course or supplementary material is provided by the full-time graphic artist from the ETV production staff and in some cases, by students employed on a part-time basis.

The Coast Community College District used a total of 24 people in designing an anthropology course for ETV. The team included 15 district faculty members, two recognized authorities in the field, a television producer and the textbook producers. With Outreach Consortium, the course design team was comprised of 75 faculty, 42 representatives of community agencies, and 17 television personnel. In both situations, a course coordinator with a background in education but not holding a faculty position held the final decisionmaking responsibility.

With British Open University, there is a mix of 20 to 30 ETV personnel, academics and others who function as a course team throughout the entire planning and design phase, with all team members given an equal vote on the course content and design.

The Stanford University Engineering telecourses, on the other hand, are selected almost entirely by the Director of the Stanford Instructional Television Network upon weighing such factors as historical trends in enrollments, requests from the industry-user institutions, and new subject areas of popular interest. In the Stanford case, the faculty committed themselves to the ETV programming when the Engineering ETV telecasting was initiated and thus there is minimal need for their continuing involvement in the quarterly scheduling. Since the curriculum is the same as that delivered on campus, it is not necessary to design courses for ETV *per se*, but the faculty is responsible for course content. In addition, when material is to be exported for use on videotape rather than over the network's two-way audio system, a faculty representative meets with the industry-user to plan a course or series of courses which will meet the user's need.

The Association for Continuing Education initiates the planning process when the ACE director meets with the management of the industry user to plan the type of course needed to meet that industry's need and to identify the type of expertise required by the ETV instructor. In this situation, the industry user frequently has an idea of an individual in the Bay Area who possesses the required experience and expertise, and this person is then contacted by the ACE director. The planning phase is completed when industry management, the ACE director, and the ETV instructor meet to agree on course content. The ETV instructor is then responsible for designing the course.

b. Time Required

As shown in Table 5-1 (page I-173), the range in total time required for planning and designing an ETV course is two and a half weeks to two years for the case studies investigated. The Association for Continuing Education provides an example for the lower bound where the interaction between the ACE director, user institution and ETV instructor takes 26 to 32 hours, and the instructor who is responsible for designing the course requires an additional 66 hours to develop a 22-segment course and one-half to 8 hours in learning to use the medium.

The two-year period noted in Table 5-1 for Oregon State University reflects a situation where courseware planning is begun two years in advance of the scheduled release. Actually, the instructor who is responsible for designing and developing the course is released from one third to one half of his normal teaching load to do so which would represent approximately four to six weeks out of the twelve-week quarter. Not noted on the table is the fact that personnel at the ETV production center work throughout the year with the faculty to plan and design the special films for their closed circuit TV network, and to update or revise existing ETV courses.

For both the Coast Community College District and the Outreach Consortium, the two-year period reflects the fact that planning, designing and producing a course occur simultaneously. Similarly, the six months to one year noted for British Open University includes the course team's time in planning, designing and production.

Following approximately two weeks of planning by Chicago TV College's dean and faculty members from the appropriate departments, the ETV instructor has seven and one half months to design and produce an ETV course.

c. ETV Course Design and Setting

In each case study examined, the approach used for course design is a function of the educational objective and the institutional setting. Therefore, until Iran establishes objectives and the individual settings for course preparation and delivery are identified, no detailed recommendations can be made for either course design or production.

In the Chicago TV College case, for example, the College is set up as an extension of a larger group of traditional city colleges. Having no faculty of its own, it must provide incentives for ETV instructors. These are summer employment (Chicago's teachers are generally not teaching in the summer), and leave of duty for an entire semester to develop an ETV course. The College has to pay the TV teacher's salary over this time, and in order to stay within budget, generally uses one instructor to design a course. It is noted that this approach has been successful in the Chicago case, as evidenced by the fact that TV College has produced more ETV courses than any other postsecondary institution.

In the Oregon State University case, ETV courses were initiated to meet the problems of oversized classes and limited classroom facilities and faculty. ETV instructors are provided incentive in the form of released time for part of a quarter's teaching load (in contrast to the Chicago situation of an entire semester's released time and additional summer salary). Primarily for budget reasons, one instructor is used to design an ETV course. This approach has been successful in terms of allowing 70 percent of the total yearly ETV enrollment to attend telecast lectures off campus, and providing for reduced staff salaries by using teaching assistants (TA's) in a ratio of 1:30 students for ETV courses.

Stanford and ACE both provide examples of planning to meet the needs of local industry in upgrading the skills of their employees. With Stanford, faculty support was needed when the engineering telecourse programs were initiated, and with ACE, an instructor is sought out for specific programs, but in both cases, the primary motivater is the user industry.

While both the Coast Community College District and Outreach Consortium placed heavy reliance on faculty input to ensure academic quality, the person with the ultimate control of the course is a nonfaculty coordinator. This may be due to the large population that is to be served, recognizing, in general, a media-sophisticated audience is accustomed to being entertained in contrast to being lectured at, and to the objective in both cases of producing exportable ETV material.

British Open University spent several years in comprehensive planning of their innovative educational system. As no exact model was in existence, it was decided that the course team would consist of 20 to 30 people with a range of talents: recognized authorities in the subject area, television experts, and educational researchers. This approach is being continuously evaluated by the University's in-house research group and appears to be successful (see Chapter III, p. I-100).

2. Production of ETV Courses

As observed in the design phase, the range of possible production processes is also broad. Three elements of the production process are examined in the case studies:

- Facilities and equipment;
- Personnel required;
- Cost.

a. Facilities and Equipment

Facilities may consist of studio classrooms and a studio auditorium, as is the case with Stanford and the Association for Continuing Education; or a full-fledged commercial-type studio as in the Coast Community College District, Outreach Consortium and Chicago TV College situations; or it may be one studio classroom and a studio that doubles as a receiving classroom which is what Oregon State University has.

Equipment can be as simple as one monochrome video camera, one monochrome video tape recorder, one video monitor, and cables, a microphone and a tripod, or as sophisticated as a fully equipped color studio with an adjunct portable van also equipped for color.

The key consideration is to determine whether or not the facilities and equipment fill the need of the user institution. In the case studies examined, the efficiency and effectiveness of the systems, as previously discussed in Chapter III, would seem to attest to the fact that various production and delivery systems can be employed to meet an educational goal.

b. Personnel Required

Oregon State University maintains its ETV production effort of 58 hours of courses and an undetermined number of special films with a full-time staff of five, including the secretary, who may be called upon for camera work, and with part-time students in a government-subsidized work program. On the other hand, Coast Community College District and the Outreach Consortium produced 30 hours in one year and 15 hours in two years respectively while having access to a 60-person production staff. Comparatively, Open University also has a 60-person production staff and produces 125 hours/year. Table B-1 points out the broad range of possibilities.

c. Cost

For the purposes of this investigation, cost is measured in terms of dollars per produced hour of ETV courses. As indicated in Table B-1, the lowest of these is the $118 per hour figure for the Stanford University engineering telecourses and the highest is $90,000 for the Coast Community College District and Outreach Consortium.

It is not possible to make an absolute judgment of the relationship between cost, and system efficiency and effectiveness. To underscore the magnitude of the problem, the Chicago TV College, with production costs of $3,172/hour of produced ETV material maintains a student retention rate on the order of 65 to 80 percent, while the Coast Community College District, with the high production costs cited above, has a 35 percent retention rate.

There is no clear answer as to what is a necessary level of production sophistication. Since ETV has been effective at low cost it is important for Iran to determine the purposes for which it will use television, review other relevant experiences in more detail, and design and test the material selected.

APPENDIX 5A

Survey Results - Design and Production

Detailed information is contained in this appendix on the following institutions in the order listed:

- Chicago TV College
- Coast Community College District
- Outreach Consortium
- Stanford University
- Association for Continuing Education
- Oregon State University
- British Open University

Table 5A-1

Chicago TV College: Course Production [5,6,7]

Courses are produced for the purpose of bringing postsecondary education to those in the Chicago metropolitan area who would otherwise be unable to receive it through traditional channels. The TV College is an extension of the City Colleges of Chicago system.

Planning and Design

. Personnel	Planning personnel include faculty representatives from other colleges in the system, the Dean of the Learning Resources Laboratory and TV College, and the TV instructor (usually selected from the faculty representatives group). Design personnel include the TV instructor, the Dean of the Learning Resources Laboratory and TV College, the Dean of the Department (e.g., Language), and the producer/director.
. Time/Function	Faculty representatives and Dean of TV College meet four times for two hours to plan general course content and select TV instructor (8 hours). TV instructor has one summer plus one semester to design course content and to tape course (7.5 months). Producer/director works with TV instructor on use of the media and on producing ETV material (6 months). Graphic artists work with TV instructor and producer/director to prepare film inserts, special effects, etc., and to prepare supplementary support material (6 months). Dean of TV College and dean of department represented observe TV instructor's on-camera presentation, approve content and delivery of two or more course segments (precise time not available).

Table 5A-1 - Cont'd.

Studio hours/ produced hours	Three hours per hour.

Production

Facilities	Rent space from WTTW, Chicago's educational television station. Equipment includes color cameras, switching equipment, videotape recorders, film/slide chain equipment, audio consoles, monitors, microphones and speakers, lighting. Pretaped courses are transmitted by open circuit via WTTW to Chicago-area homes.
Process and Team	TV instructor, producer/director, studio crew (including cameramen, lighting and audio men, engineers) rehearse and videotape course segments for future transmitting.
Cost	Example 1 - Average course of 30 45-minute segments

Production studio rental	$ 30,375
Producer/director's salary	10,000
Graphic artist's salary	6,500
TV instructor's salary	22,000
Administrative and clerical support	2,500
	$ 71,375
Transmission (each segment shown twice)	7,000
Printing guides and examinations	2,000
Total	$ 80,375
Cost per segment (production)	$ 2,379
Cost per segment (delivery)	300

Table 5A-1 - Cont'd.

Example 2 - Special series

Four times more studio rental required for production than for average course series	$121,500
Other factors (assuming no change)	50,000
Total	$171,500
Cost per segment	$ 5,717

Cost per hour: $3,572-$7,622

Table 5A-2

Coast Community College District:
Course Production [8]

Produces ETV courses for the purpose of offering community college courses for credit to residents of Orange County, California via open telecast on an educational television station and for export to other colleges.

Planning and Design

Personnel	Example: "Dimensions in Culture" (Anthropology) - TV production experts, experts in the field, academics, textbook designers.
Time/Function	Overall course planning, design and production took 2 years. No specific breakdown of time available. By function, personnel included: 1 recognized academic expert -- to plan overall course content 1 TV producer -- to coordinate course planning for TV with what can be accomplished by the media 15 faculty -- to provide educational input 5 text producers -- to plan, design and coordinate text with ETV course 2 recognized authorities, one to assist in course design and the other to review design and content
Studio Hours/ Produced Hours	15 hours per hour

Production

Facilities	Completely equipped UHF educational television station using commercial studio

Table 5A-2 - Cont'd.

	with the following equipment: color cameras, videotape recorders, videotape receivers, film/slide chain equipment, consoles, monitors, microphones, speakers, lighting, remote pickup van with color cameras and a videotape recorder.
• Process and Team	TV producer to coordinate 5 outside film crew to provide input for ETV course. 3 graphics experts to provide input to video course. 8 in-studio crew, including engineers, directors, film splicers, etc., to produce ETV course. Commercial publisher's personnel, including layout experts, editors, etc., to produce supplementary material.
• Costs	$1,000-$1,500/minute (1975 dollars) $900,000-$1,350,000 for a course comprised of 30 30-minute segments and the associated supplementary material. $60,000-$90,000/hour

Table 5A-3

Outreach Consortium: Course Production [8,9]

Produced a course, "Contemporary California Issues" as a pilot project combining educational, governmental and business resources within the community with TV production expertise to provide high quality ETV for Orange and San Diego Colleges and for export.

Planning and Design

. Personnel	Example: "Contemporary California Issues"- 75 faculty representatives and 42 representatives of community agencies and citizens formed into 9 module groups to plan and design course. TV coordinators interacted in this phase.
. Time/Function	Overall course planning, design and production took 2 years. For an overview of the process, see Figure 5A-1.
. Studio Hours/ Produced Hours	15 hours

Production

. Facilities	Same as for Coast Community College District
. Costs	$1,500/minute (1975 dollars) $900,000 for a course comprised of 20 30-minute segments, 9 audio segments, and associated supplementary material. $90,000/hour

OUTREACH EXECUTIVE COMM.: OUTREACH BOARD OF DIRECTORS	GENERAL DESIGN TEAM	CURRICULUM DESIGN TEAM	SPECIFIC MODULE DESIGN TEAM	CBN PRODUCTION DESIGN TEAM	PRINT PRODUCTION TEAM	VIDEO PRODUCTION TEAM	ADMINISTRATIVE UTILIZATION TEAM	PUBLISHING UNIT		DATES
Approval							Team assigned			7/1/75 - 6/30/75
Selection and approval of teams		Conduct general objective exercise with testing Select and assign module design team	Refine general objectives into content related obj. with tests	Team assigned	Team assigned	Team assigned	Conduct search of existing material			7/1/75 - 9/30/75
Write and seek Board of Dir. approval for remaining phases Submit to funding agency	Approval of module contents Approval of production designs	Approval of module contents	Articulate content of each module	Consider instruc design segment Do CBN production model design	Consider instr. design segment Do print prod. model design	Consider instruc. design segment Do video prod. model design	Consider instr. design segment Do utilization design Survey potential users			10/1/75 - 12/30/75
Seek funding for PBS release Approval NEH grant		Consult with production teams	Consult with production teams	Pre-prod. of pilot	Pre-production of pilot	Pre-production of pilot	Process survey			1/1/76 - 3/31/76
Approve pilot package	Approve pilot package	Validate pilot	Consult with production teams Validate pilot	Production of pilot Validate pilot	Production of pilot Validate pilot	Production of pilot Validate pilot	Revise utilization process Outline administrative package Outline promo. package Outline PBS Station package	Bidding for: Text Study Guide CBN lectures After selection: market assessment Review pilot package	LANGUAGE TRANSLATION	4/1/76 - 6/30/76
	Approve intended production Review pkg. drafts Add translation segment Review translation outline	Approve intended production	Pre-prod. conf. with guidelines to produce teams	Pre-prod. conference Begin CBN production	Draft text outline Draft study guide	Pre-production of video segments	Draft: Admin. package w/o Faculty guide Promo. package PBS Station package	Participate in print segment	Outline translation process objectives	7/1/76 - 9/30/76
	Approve text validation sequence	Consult Validate text	Consult Validate text and CBN	Production of CBN and validate for objectives First edit of CBN	Production of text and validate for object First edit of text	Begin video production	Revise: Admin. package w/o fac. guide Promo. package PBS Station pckg. Final in-house edit	First edit of CBN First edit of text	Translation begins	10/1/76 - 12/31/76
		Consult	Consult	Final edit of CBN booklet	Rewrite and final edit of text Production of study guide	Cont'd video production	Draft of faculty guide, admin. pkg. segment Begin promotion	Final edit of CBN, text		1/1/77 - 3/31/77
		Consult Validate study guide and faculty segment	Consult Validate study guide and faculty segment		Final prod. of study guide and edit Validate Final edit of study guide	Cont'd video production	Cont'd promo. Confirm station participation Confirm Institut. participation Confirm news part. Final edit of faculty segment	Publication of text, CBN booklet Final edit of study guide		4/1/77 - 6/30/77
Course premiere to: Board, public, news	Approve course validation	Validate complete course	Validate complete course			Video tapes completed, distributed	Utilization contracts Distribution of: Admin. pkg. w/faculty guide PBS Station pkg. Support utilization	Publication of study guide Distribution of: text study guide CBN lectures		7/1/77 - 9/15/77
III						Ready for air	Admin. pkg. w/faculty guide at institutions PBS Station pkg. in use	ON SALE IN BOOKSTORES: text study guide CBN lectures		9/15/77 - 12/31/77
Evaluation	Evaluation					Evaluation	Evaluation	Evaluation	Translation and dubbing complete	1/1/78 - 6/30/78
Update	Update					Update	Update	Update	Distribution of International Production	7/1/78 - 6/30/79

Table 5A-4

Stanford University Engineering Telecourses:
Course Production [10,11,12]

Courses not planned for ETV per se; choice of courses for schedule depends on (1) demand from users at remote sites, (2) feedback from faculty to network on what courses can be expected to draw large enrollments, (3) review of past trends, etc.

Planning and Design

Personnel	Faculty, users at remote sites, Director of network.
Time/Function	Director of network carries bulk of responsibility for planning schedule; spends approximately 20-40 hours/quarter. Instructor prepares lecture notes and supplementary reading aids to complement the video lecture. 2 hours/lecture hour. Faculty and network representative may meet with user institution in special cases to interview and select an institution-based TA (4 hours).

Production

Facilities	4 studio classrooms and 1 auditorium at Stanford. Studio classrooms equipped with 2 TV cameras, monitors, film chains, switches, lighting equipment, projectors, videotape recorders for transmission to antenna installation. Every two students in studio classroom share a TV monitor with talk-back microphone for communicating with instructor and students in remote locations. Instructional programs may be telecast over 4 channels of Stanford ITV network simultaneously. Programs are transmitted by microwave to antenna installation, and retransmitted using narrow-beam microwave channels to television classrooms in user institutions.

Table 5A-4- Cont'd.

	Each studio classroom has an individual talk-back channel so that remote students can be heard by instructor and by each other. This is accomplished by a microwave talk-back link on each of the 4 Stanford network channels. User institutions are equipped with rooftop antenna to receive programming, a converter, cabling, and classrooms with receiving TV sets. Typical remote classroom is equipped with TV monitors and talk-back equipment. Transmission to 36 remote sites.
• Process and Team	Live transmission by professor picked up by 2 cameras -- 1 focuses on professor and the second on graphic material (e.g., notepad, blackboard, etc.). Technician in control room connected with studio classroom operates cameras via remote control, sets audio levels, and chooses picture to be presented on student monitors. Engineer in master control room at receiving antenna site can insert pretaped segments before transmitting lecture to user institutions. Lecture notes and readings are made available to students to supplement the video. Videotapes of live lectures may be kept by user institution for 2 weeks to allow for student review, etc. Must then be destroyed.
• Costs	$118/hour.

Table 5A-5

Association for Continuing Education: Course Production [10,11,12,13]

Courses planned to meet specific needs of business and industry in the San Francisco Bay Area including MBA program, Cybernetics graduate and post-graduate courses, and special interest courses to meet specified needs for in-training of personnel.

Planning and Design

Case A: Development of Special Course

Personnel	ACE manager, head of department at user institution, training manager at user institution (if applicable), TV instructor (for courses not "imported"), ACE staff associates.
Time/Function	ACE Manager: 20 hours to meet with user, instructor, and training manager in various exploratory and planning sessions. Head of Department (User Institution): 3-6 hours meeting with training manager to discuss need, with ACE manager to discuss course, meet with instructor to discuss course, etc. Training Manager (User Institution): 3-6 hours meeting with head of department to discuss need for course, with ACE manager and instructor to discuss course requirements, etc. TV Instructor (New): 3 hours per lecture hour (includes preparation of video lecture and supplementary material). TV Instructor (Experienced): 2 hours per lecture hour. Staff Associate: 8 hours working with new instructor on use of the media; 1/2 hour with experienced instructor on the Stanford system.

Table 5A-5 - Cont'd.

Case B: Development of MBA Program

· Personnel	ACE manager, representatives of user institutions, representatives of College of Notre Dame and Golden Gate Colleges, TV instructors.
· Time/Function	ACE Manager: 52 hours to meet with user institutions to identify MBA courses useful to business and industry in Bay Area. 320 hours to recruit TV instructors, plan courses, meet with user institutions, etc. (based on 20 hours/course for 16 core courses in MBA program). 160 hours to perform same function as above for foundation course for MBA (based on 20 hours/course for 8 courses). Head of Department (User Institution): 6-12 hours to preplan with ACE manager, consult with staff, consult with instructor (in some cases), discuss with management, etc. TV Instructor (New): 3 hours/lecture hour. TV Instructor (Experienced): 2 hours/lecture hour. College Representatives: (Time not available.) Meet with ACE to negotiate arrangement.

Production

· Facilities	ACE uses the same Stanford ITV network facilities described for Engineering. Transmission as of September 1974 to 80 classrooms at 20 remote sites.

Table 5A-5 Cont'd

. Process and Team	Example #1: Instructor-lecturer for the foundation MBA course, the MBA course, and the Cybernetics course follows a production process similar to Stanford Engineering Telecourses. Example #2: Special course delivered live to local user institutions. Course is put on videotape for dissemination to other user institutions which are outside of the range of the Instructional Television Fixed Service (ITFS) system. Example #3: Special short courses on videotape produced in studio or classroom, or imported, may be telecast to user institutions.
. Costs	Per hour produced and distributed ETV hour: $141.

Table 5A-6

Oregon State University: Course Production [14,15,16]

ETV material is produced to meet the needs of an expanding enrollment and desire for small class sizes, and to combine innovative teaching methods with traditional approaches.

Planning and Design

Personnel	Head of department involved, ETV producer, Director of ETV Center, TV instructor.
Time/Function	Time frame for planning is 2 years ahead of release of course. Department chairman and faculty meet to determine (1) if ETV can serve to increase the effectiveness of course presentation, (2) if a course "in use" needs revision, (3) if a new series should be developed, etc. Director of ETV Center and ETV producer/director meet with faculty involved when decision has been made to use ETV. No time breakdown except for TV instructor who is released from 1/3 to 1/2 of his normal teaching requirements to develop a 20-segment course (4-6 weeks).
Studio Hours/ Produced Hours	2 hours per hour.

Production

Facilities	1 TV classroom equipped with cameras, lighting equipment, monitors, film chains, switches, videotape recorders, projectors. Also studio with 2 cameras, monitor booth, audio equipment, etc. Equipment dates back to mid-60s with color capability now being added. On occasion State educational TV station facilities are loaned for color videotaping without charge.

Table 5A-6 - Cont'd

. Process and Team	Full-time employees include the Director of the ETV Center, 2 engineers, 2 producer/director/writers, 1 graphic artist, and a secretary. Students are used on a part-time basis for graphics and camera work.
. Cost	Director estimates a range of $700-$5,000 per individual lesson (45 minutes). $933-$6,666/hour

TABLE 5A-7

British Open University: Course Production [17,18,19,20]

ETV material produced as part of a multimedia package to support, enrich, illuminate, or otherwise strengthen the learning experience of the student.

	Foundation Level	Higher Levels
Planning and Design		
. Personnel	Course design team of 20-30 individuals comprised of OU faculty, BBC producers, outside consultants, representatives from the Institute for Educational Technology (IET).	Similar to foundation level.
. Time/ Function	While an exact time breakdown is not known at this time, it has been estimated that each team produces 1 or 2 courses per year. Aggregate functions of team members are described as follows: Academic staff: develop course content and define academic objectives. BBC personnel: preparation and production of video. Outside consultants: assist in development of content. IET: incorporation of newest educational methodologies.	
. Studio Hours/ Produced Hours	Not available.	
Production		
. Facilities	Main television studio at Alexandra Hall which is a self-contained production unit with equipment for recording, editing and replaying video and audio tape; a video rostrum area for recording still and animated caption sequences; 5 film cutting rooms for dubbing, editing and reviewing; scenic, graphic design and photographic areas. Also a monochrome outside broadcast unit with a separate mobile videotape vehicle is available. Plans call for equipping both studio and mobile unit for color in 1975.	
. Process and Team	Process includes integration with course design team. Of the approximately 60 members of the production staff, there is a broad range of scientists, mathematicians, technologists, social scientists, educationists and arts members, nearly all of whom have a degree and several with previous experience in teaching adults. These people have acquired the necessary television and radio broadcasting expertise and now function as a production team independent from the BBC.	
. Costs	$1,000 per 25-minute program. $32,000 per foundation level course (approximately $1,500,000/year budget for ETV production). $2,400/hour	

APPENDIX C

DEGREE PROGRAM COURSE LISTINGS

DEGREE PROGRAMS

1. SCHOOL OF ARTS AND SCIENCES
2. SCHOOL OF ENGINEERING

DEGREE PROGRAMS

SCHOOL OF ARTS AND SCIENCES

DEGREE PROGRAM IN ECONOMICS

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
English 101	4	1	1	Common	
Mathematics 103	3	1	1	Major	
History 101	3	1	1	Major	
History of Sc. 101	3	1	1	Common	1
Persian 102	3	1	2	Common	
English 102	4	1	2	Common	
Mathematics 104	3	1	2	Major	
History 102	3	1	2	Major	
Optional (B)	3	1	2	Optional	2
English 201	3	2	1	Major	
Business Adminis.101	3	2	1	Major	
Economics 201	3	2	1	Major	
Optional (B)	6			Optional	2
English 202	3	2	2	Major	
Business Adminis. 201	3	2	2	Major	
Economics 202	3	2	2	Major	
Optional (B)	6	2	2	Optional	2
Business Adminis. 202	3	3	1	Major	
Economics 301	3	3	1	Major	
Economics 311	3	3	1	Major	
Mathematics 313	3	3	1	Major	
Optional (A)	6	3	1	Optional	3
Economics 302	3	3	2	Major	
Economics 303	3	3	2	Major	
Mathematics 314	3	3	2	Major	
Optional (A)	6	3	2	Optional	3
Optional (B)	3	3	2	Optional	2
Economics 312	3	4	1	Major	
Optional (A) (400 or above)	3	4	1	Optional	3
Optional (A)	3	4	1	Optional	3
Elective	6	4	1	Elective	4
Optional (A) (400 or above)	3	4	2	Optional	3
Optional (A)	6	4	2	Optional	3
Elective	6	4	2	Elective	4

DEGREE PROGRAM IN HISTORY

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
English 101	4	1	1	Common	
Mathematics 101	3	1	1	Major	
Education 201	4	1	1	Common	1
History of Civ. 101	3	1	1	Major	
Persian 102	3	1	2	Common	
English 102	4	1	2	Common	
Mathematics 102	3	1	2	Major	
Psychology 203	4	1	2	Common	
History of Civ. 102	3	1	2	Major	
English 201	3	2	1	Common	
History 201	3	2	1	Major	
History 205	3	2	1	Major	
Anthro. 203	3	2	1	Common	
Elective (B)	3	2	1	Elective	5
German or French 101	3	2	1	Major	
English 202	3	2	2	Common	
History 202	3	2	2	Major	
History 206	3	2	2	Major	
Elective (B)	3	2	2	Elective	5
Elective (B)	3	2	2	Elective	5
German or French 102	3	2	2	Major	
History 301	3	3	1	Major	
Elective (A)	3	3	1	Elective	6
Elective (B)	3	3	1	Elective	5
German or French 201	3	3	1	Major	
Optional	3	3	1	Optional	4
History 302	3	3	2]	Major	
Elective (A)	3	3	2	Elective	6
Elective (B)	3	3	2	Elective	5
German or French 202	3	3	2	Major	
Optional	3	3	2	Optional	4
History 401	3	4	1	Major	
History 411	3	4	1	Major	
History 403	3	4	1	Major	
Elective (A)	3	4	1	Elective	6
Optional	3	4	1	Optional	4

DEGREE PROGRAM IN HISTORY (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
History 401	3	4	1	Major	
History 411	3	4	1	Major	
History 403	3	4	1	Major	
Elective (A)	3	4	1	Elective	6
Optional	3	4	1	Optional	4
History 402	3	4	2	Major	
History 412	3	4	2	Major	
History 404	3	4	2	Major	
Optional	3	4	2	Optional	4
Thesis (History 490)	3	4	2	Major	

DEGREE PROGRAM IN MATHEMATICS

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
Mathematics 105	3	1	1	Major	
Physics 105	3	1	1	Major	
History of Sci. 100	3	1	1	Common	1
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Mathematics 106	3	1	2	Major	
Physics 106	3	1	2	Major	
Physics Laboratory 110	1	1	2	Major	
Optional	3	1	2	4	
English 201	3	2	1	Common	
Mathematics 201	3	2	1	Major	
Physics 107	3	2	1	Major	
Physics Laboratory 111	1	2	1	Major	
Mathematics 301	3	2	1	Major	
Elective	3	2	1	Elective	5
English 202	3	2	2	Common	
Mathematics 202	3	2	2	Major	
Mathematics 205	3	2	2	Major	
Mathematics 302	3	2	2	Major	
Elective	3	2	2	Elective	5
Mathematics 303	3	3	1	Major	
Statistics 305	3	3	1	Major	
Mathematics 307	3	3	1	Major	
Elective	3	3	1	Elective	5
Optional	3	3	1	Optional	4
Mathematics 304	3	3	2	Major	
Statistics 306	3	3	2	Major	
Mathematics 309	3	3	2	Major	
Elective	3	3	2	Elective	5
Optional	3	3	2	Optional	4
Elective (Math)	6	4	1	Major	7
Optional	3	4	1	Optional	4
Elective	6	4	1	Elective	8
Elective (Math)	9	4	2	Major	7
Elective	9	4	2	Elective	8

DEGREE PROGRAM IN PHYSICS

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Physics 105	3	1	1	Major	
Mathematics 105	3	1	1	Major	
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
History of Science 100	3	1	1	Common	
Physics 106	3	1	2	Major	
Mathematics 106	3	1	2	Major	
Physics Laboratory 110	1	1	2	Major	
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Elective	3	1	2	Elective	4
Physics 107	3	2	1	Major	
Physics Laboratory 111	1	2	1	Major	
Mathematics 201	3	2	1	Major	
English 201	3	2	1	Common	
Chemistry 105	3	2	1	Major	
Elective	3	2	1	Elective	4
Physics 216	1	2	2	Major	
Physics 301	3	2	2	Major	
Physics 304	3	2	2	Major	
Mathematics 202	3	2	2	Major	
English 202	3	2	2	Common	
Chemistry 106	3	2	2	Major	
Physics 303	3	3	1	Major	
Physics 305	4	3	1	Major	
Mathematics 205	3	3	1	Major	
Chemistry 107	1	3	1	Major	
Optional	3	3	1	Optional	10
Optional (Physics)	3	3	1	Optional	9
Physics 217	1	3	2	Major	
Physics 306	4	3	2	Major	
Physics 326	3	3	2	Major	
Physics 432	3	3	2	Major	
Optional	3	3	2	Optional	10
Elective	3	3	2	Elective	4
Physics 411	3	4	1	Major	
Optional (Physics)	6	4	1	Optional	9
Optional	6	4	1	Optional	10

DEGREE PROGRAM IN PHYSICS (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Physics 316	2	4	2	Major	
Physics 418	3	4	2	Major	
Optional (Physics)	5	4	2	Optional	9
Optional	3	4	2	Optional	10
Elective	3	4	2	Elective	4

DEGREE PROGRAM IN NURSING EDUCATION

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
English 101	4	1	1	Common	
Mathematics 101	3	1	1	Major	
Biology 101	4	1	1	Major	
History of Science 101	3	1	1	Common	
Persian 102	3	1	2	Common	
English 102	4	1	2	Common	
Mathematics 102	3	1	2	Major	
Biology 102	4	1	2	Major	
Psychology 201	3	1	2	Major	
Psychology 203	3	1	2	Major	
English 201	3	2	1	Major	
Sociology 201	3	2	1	Major	
Psychology & Educa. 305	3	2	1	Major	
Psychology 207	3	2	1	Major	
Nursing 305	3	2	1	Major	
Nursing 405	3	2	1	Major	
Business Adminis. 101	3	2	1	Major	
English 202	3	2	2	Major	
Sociology 202	3	2	2	Major	
Education 301	3	2	2	Major	
Nursing 301	3	2	2	Major	
Nursing 306	3	2	2	Major	11
Nursing 307	3	2	2	Major	
Nursing 403	4	3	1	Major	
Nursing 407	3	3	1	Major	
Elective	9	3	1	Elective	12
NURSING ADMINISTRATION					
Nursing 302	3	3	1		
Nursing 401	4	3	1		
Nursing 407	3	3	1		
Elective	6	3	1	Elective	12

DEGREE PROGRAM IN ENGLISH LANGUAGE AND LITERATURE

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
Mathematics 101	3	1	1	Major	
History 101	3	1	1	Major	
English 103	4	1	1	Common	
Applied Sciences	4	1	1	Optional	2
Persian 102	3	1	2	Common	
Mathematics 102	3	1	2	Major	
History 102	3	1	2	Major	
English 104	4	1	2	Common	
Applied Sciences	4	1	2	Optional	2
English 203	3	2	1	Common	
Foreign Language	3	2	1	Major	
History of Science 101	3	2	1	Common	
Two Req. English Courses	6	2	1	Major	
English 204	3	2	2	Common	
Foreign Language	3	2	2	Major	
Elective	3	2	2	Elective	4
Two Req. English Courses	6	2	2	Major	
Foreign Language	3	3	1	Major	
Elective	3	3	1	Elective	4
Three Required English Courses	9	3	1	Major	
Foreign Language	3	3	2	Major	
Optional (B)	3	3	2	Optional	5
Three Optional English Courses	9	3	2	Optional	16
Persian 423	3	4	1	Major	
Three Required English Courses	9	4	1	Major	
Elective	3	4	1	Elective	4
Optional	3	4	1	Optional	5
Persian 424	3	4	2	Major	
Three Optional English Courses	9	4	2	Optional	16
Elective	3	4	2	Elective	4
Optional (B)	3	4	2	Optional	5

DEGREE PROGRAM IN GEOLOGY

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
Physics 103	3	1	1	Major	
Mathematics 103	3	1	1	Major	
Geology 101	4	1	1	Major	
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Physics 104	3	1	2	Major	
Mathematics 104	3	1	2	Major	
Geology 102	4	1	2	Major	
English 201	3	2	1	Common	
Chemistry 105	3	2	1	Major	
Optional	3	2	1	Optional	8
Biology 101	4	2	1	Major	
Geology 203	4	2	1	Major	
English 202	3	2	2	Common	
Chemistry 106	3	2	2	Major	
Optional	3	2	2	Optional	8
Biology 102	4	2	2	Major	
Elective	3	2	2	Elective	4
Geology 201	4	3	1	Major	
Geology 301	4	3	1	Major	
Geology 303	3	3	1	Major	
Chemistry 107	1	3	1	Major	
Sociology	3	3	1	Major	
Geology 202	3	3	2	Major	
Geology 302	4	3	2	Major	
Geology 304	3	3	2	Major	
Elective	3	3	2	Elective	4
Optional	4	3	2	Optional	8
Geology 401	2	4	1	Major	
Geology 305	3	4	1	Major	
Geology 319	3	4	1	Major	
Optional	4	4	1	Optional	8
Elective	3	4	1	Elective	4
Geology 405	3	4	2	Major	
Geology 410	8	4	2	Major	
Elective	3	4	2	Elective	4

DEGREE PROGRAM IN PSYCHOLOGY AND EDUCATION

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
History 101	3	1	1	Major	
English 101	4	1	1	Common	
Mathematics 103	3	1	1	Major	
Biology 101	4	1	1	Major	
*Persian 102	3	1	2	Common	
History 102	3	1	2	Major	
English 102	4	1	2	Common	
Mathematics 104	3	1	2	Major	
Biology 102	4	1	2	Major	
English 201	3	2	1	Major	
Education 201	3	2	1	Major	
*Psychology 203	3	2	1	Major	
Optional	3	2	1	Optional	8
Social Science	3	2	1	Major	
English 202	3	2	2	Major	
Education 230	3	2	2	Major	
Psychology 207	3	2	2	Major	
Optional	6	2	2	Optional	8
Psychology 301	3	3	1	Major	
Education 305	3	3	1	Major	
Psychology 340	3	3	1	Major	
Optional	3	3	1	Optional	13
Elective	3	3	1	Elective	
Psychology 309	3	3	2	Major	
Education 326	3	3	2	Major	
Optional	6	3	2	Optional	8
Elective	3	3	2	Elective	
Psychology 401	3	4	1	Major	
Psychology 405	3	4	1	Major	
Psychology 428	3	4	1	Major	
Optional	6	4	1	Optional	13
Elective	3	4	1	Elective	
Psychology 403	3	4	2	Major	
Psychology 407	3	4	2	Major	
Education 426	3	4	2	Major	
Optional	3	4	2	Optional	13
Elective	3	4	2	Elective	

*1975 ETV Course

DEGREE PROGRAM IN CHEMISTRY

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
Mathematics 105	3	1	1	Major	
Chemistry 105	3	1	1	Major	
Physics 105	3	1	1	Major	
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Mathematics 106	3	1	2	Major	
Chemistry 106	3	1	2	Major	
Physics 106	3	1	2	Major	
Chemistry 108	2	1	2	Major	
English 201	3	2	1	Common	
Physics 107	3	2	1	Major	
Chemistry 221	3	2	1	Major	
Social Sciences	3	2	1	Major	
Mathematics 205	3	2	1	Major	
Physics 110	1	2	1	Major	
English 202	3	2	2	Common	
Physics 111	1	2	2	Major	
Chemistry 222	3	2	2	Major	
Optional	3	2	2	Optional	2
Elective	3	2	2	Elective	4
Chemistry 226	2	2	2	Major	
Physical Chemistry 331	3	3	1	Major	
Anal. Chemistry 341	2	3	1	Major	
Anal. Chemistry Lab 343	1	3	1	Major	
Inorganic Chemistry 351	3	3	1	Major	
Optional	3	3	1	Optional	2
Elective	3	3	1	Elective	4
Organic Chemistry 324	3	3	2	Major	
Physical Chemistry 332	3	3	2	Major	
Anal. Chemistry 342	2	3	2	Major	
Anal. Chemistry Lab 344	2	3	2	Major	
Inorganic Chemistry 352	3	3	2	Major	
Elective	2	3	2	Elective	4
Physical Chemistry 433	2	4	1	Major	
Organic Chemistry 424	2	4	1	Major	
Organic Chemistry 425	3	4	1	Major	
Chemistry 445	2	4	1	Major	
Seminar 490	1	4	1	Major	
Optional	3	4	1	Optional	2
Elective	3	4	1	Elective	

DEGREE PROGRAM IN CHEMISTRY (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Organic Chemistry 427	3	4	2	Major	
Physical Chemistry 434	3	4	2	Major	
Chemistry 446	2	4	2	Major	
Chemistry 447	3	4	2	Major	
Optional	3	4	2	Optional	2
Elective	3	4	2	Elective	

COURSE PROGRAM IN BIOLOGY

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
English 101	4	1	1	Common	
Social Sciences	3	1	1	Common	
Mathematics 103	3	1	1	Major	
Chemistry 105	3	1	1	Major	
Persian 102	3	1	2	Common	
English 102	4	1	2	Common	
Chemistry 106	3	1	2	Major	
Mathematics 104	3	1	2	Major	
Biology 101	4	1	2	Major	
English 201	3	2	1	Common	
Biology 102	4	2	1	Major	
Biology 103	4	2	1	Major	
Chemistry 221	3	2	1	Major	
Chemistry Laboratory 107	1	2	1	Major	
Elective	3	2	1	Elective	
English 202	3	2	2	Common	
Biology 208	4	2	2	Major	
Chemistry 222	3	2	2	Major	
Chemistry Laboratory 224	1	2	2	Major	
Optional (A)	4	2	2	Optional	
Biology 303	4	3	1	Major	
Elective	3	3	1	Elective	
Physics 103	3	3	1	Major	
Physics Laboratory 108	1	3	1	Major	
Optional (A)	4	3	1	Optional	
Biology 304	4	3	2	Major	
Elective	3	3	2	Elective	
Physics 104	3	3	2	Major	
Physics Laboratory 109	1	3	2	Major	
Optional (B)	4	3	2	Optional	8
Biology 306	4	4	1	Major	
Optional (B)	12	4	1	Optional	8
Biology 410	4	4	2	Major	
Elective	3	4	2	Elective	
Optional (A)	8	4	2	Optional	

COURSE PROGRAM IN NATIONAL DEVELOPMENT

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
English 101	4	1	1	Common	
Mathematics 103	3	1	1	Major	
History 101	3	1	1	Major	
Physics 103 and 108	4	1	1	Major	
Persian 102	3	1	2	Common	
English 102	4	1	2	Common	
Mathematics 104	3	1	2	Major	
History 102	3	1	2	Major	
Elective	3	1	2	Elective	4
English 201	3	2	1	Common	
Economics 201	3	2	1	Major	
Sociology 201	3	2	1	Common	
Biology 101	4	2	1	Major	
Irrigation 301	2	2	1	Major	
English 202	3	2	2	Common	
Economics 202	3	2	2	Major	
Sociology 202	3	2	2	Major	
Biology 104	4	2	2	Major	
Agricultural Econom. 302	3	3	1	Major	
National Development 317	3	3	1	Major	
National Development 303	3	3	1	Major	
National Development 307	3	3	1	Major	
National Development 301	3	3	1	Major	
National Development 302	3	3	2	Major	
Sociology 301	3	3	2	Major	
Animal Science 301	3	3	2	Major	
National Development 308	3	3	2	Major	
National Development 306	3	3	2	Major	
National Development 407	3	4	1	Major	
National Development 406	3	4	1	Major	
National Development 409	3	4	1	Major	
National Development 405	3	4	1	Major	
Elective	3	4	1	Elective	4
Mathematics 313	3	4	2	Major	
Sociology 305	3	4	2	Major	
National Development 413	3	4	2	Major	
National Development 416	3	4	2	Major	
National Development 426	3	4	2	Major	

COURSE PROGRAM IN NATIONAL DEVELOPMENT (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
National Development 501	3	5	1	Major	
Economics 451	3	5	1	Major	
Optional	3	5	1	Optional	2
Elective	3	5	1	Elective	4
National Development 503	3	5	1	Major	
National Development 520	3	5	2	Major	
National Development 522	3	5	2	Major	
Elective	3	5	2	Elective	4
Economics 322	3	5	2	Major	
Farm Machinery 403	3	5	2	Major	

COURSE PROGRAM IN PERSIAN

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Persian 101	3	1	1	Common	
English 101	4	1	1	Common	
Mathematics 101	3	1	1	Common	
History 101	3	1	1	Major	
Science 100	4	1	1	Major	
Persian 102	3	1	2	Common	
English 102	4	1	2	Common	
Mathematics 102	3	1	2	Major	
History 102	3	1	2	Major	
Science 100	4	1	2	Major	
Persian 103	2	2	1	Major	
Persian 201	3	2	1	Major	
English 201	3	2	1	Common	
Arabic 105 & 106	6	2	1	Major	
Elective	3	2	1	Elective	
Persian 202	3	2	2	Major	
English 202	3	2	2	Common	
Social Science	3	2	2	Major	
Arabic 205 & 206	6	2	2	Major	
Elective	3	2	2	Elective	
Persian 301	3	3	1	Major	
Persian 303	3	3	1	Major	
Persian 305	2	3	1	Major	
English 301 or French or German 101	3	3	1	Major	
Optional (A)	6	3	1	Optional	14
Persian 302	3	3	2	Major	
Persian 304	3	3	2	Major	
Persian 306	2	3	2	Major	
English 302 or French or German 102	3	3	2	Major	
Optional (A)	6	3	2	Optional	14
Persian 401	2	4	1	Major	
Persian 403	3	4	1	Major	
English 309 or French or German 201	3	4	1	Major	
Optional (A)	3	4	1	Optional	14
Elective	3	4	1	Elective	

COURSE PROGRAM IN PERSIAN (continued)

Course	Units	Year	Semester	Type	Identification Of Optional Or Elective Course
Persian 402	2	4	2	Major	
Persian 404	3	4	2	Major	
English 310 or French 201 or German 201	3	4	2	Major	
Optional	3	4	2	Optional	14
Elective	3	4	2	Elective	

SCHOOL OF ENGINEERING

DEGREE PROGRAM FOR MATERIALS SCIENCE & ENGINEERING

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Physics 105	3	1	1	Major	
Mathematics 105	3	1	1	Major	
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
Engineering Drawing 211	1	1	1	Major	
Social Science Elective	3	1	1	Elective	1
Mathematics 106	3	1	2	Major	
Physics 106	3	1	2	Major	
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Statics 221	3	1	2	Major	
Engineering Drawing 212	1	1	2	Major	
Physics Laboratory 110	1	1	2	Major	
English 201	3	2	1	Major	
Mathematics 201	3	2	1	Major	
Chemistry 105	3	2	1	Major	
Mathematics 205	3	2	1	Major	
Electrical Engr. 222	3	2	1	Major	
Physics 107	3	2	1	Major	
Physics Laboratory 111	1	2	1	Major	
Technical English 206	3	2	2	Major	
Mathematics 202	3	2	2	Major	
Chemistry 106	3	2	2	Major	
Dynamics 222	3	2	2	Major	
Electrical Engr. 282	3	2	2	Major	
Chemistry Laboratory 107	1	2	2	Major	
Electrical Engr. Lab.201	1	2	2	Major	
Engr. Mathematics 308	3	3	1	Major	
Strenth of Materials 323	3	3	1	Major	
Elec. Engr. Lab. 202	1	3	1	Major	
Materials Science I 371	3	3	1	Major	
Materials Sci. Lab. 373	1	3	1	Major	
Thermodynamics 321	3	3	1	Major	
Num. Anal. & C.P. 309	3	3	2	Major	
Fluid Mechanics 341	3	3	2	Major	
Materials Sci. II 374	4	3	2	Major	
Heat Transfer 331	3	3	2	Major	
Modern Physics 304	3	3	2	Major	

DEGREE PROGRAM FOR MATERIALS SCIENCE & ENGINEERING (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
St. and Prop. of Alloys 401	4	4	1	Major	
Instrumentation 462	3	2	1	Major	
Industrial Management 463	3	4	1	Major	
Mech.Beh. of Materials522	3	4	1	Major	
Technical Elective	3	4	1	Elective	2
Intro. to Plastics 431	3	4	2	Major	
Ceramics 451	3	4	2	Major	
Trans. & Teact. in Materials 402	4	4	2	Major	
Intro. to Metal Process 424	4	4	2	Major	
Technical Elective	3	4	2	Elective	2
MSE 491	1	Summer		Major	
METALS DIVISION					
X-Ray Diffraction 518	4	5	1	Major	
B.S. Project I 597	2	5	1	Major	
Technical Elective	7	5	1	Elective	2
Princ. of Engr. Metallurgy 523	3	5	2	Major	
B.S. Project II 598	2	5	2	Major	
Technical Elective	7	5	2	Elective	2
PLASTICS DIVISION					
X-Ray Diffraction 518	4	5	1	Major	
B.S. Project I 597	2	5	1	Major	
Technical Elective	7	5	1	Elective	2
Engr. Prop. of Polymers 536	3	5	2	Major	
B.S. Project II 598	2	5	2	Major	
Chem Engr. 506	7	5	2	Elective	2
CERAMICS DIVISION					
X-Ray Diffraction 518	4	5	1	Major	
B.S. Project I 597	2	5	1	Major	
Technical Elective	7	5	1	Elective	2
Physical Ceramics 552	4	5	2	Major	
B.S. Project II 598	2	5	2	Major	
Technical Elective	7	5	2	Elective	2

DEGREE PROGRAM FOR CHEMICAL ENGINEERING

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
Mathematics 105	3	1	1	Major	
Physics 105	3	1	1	Major	
Engr. Drawing 211	1	1	1	Major	
Humanities	3	1	1	Elective	3
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Mathematics 106	3	1	2	Major	
Physics 106	3	1	2	Major	
Engr. Drawing 212	1	1	2	Major	
Statics 221	3	1	2	Major	
Physics Lab. 110	1	1	2	Major	
English 201	3	2	1	Major	
Mathematics 201	3	2	1	Major	
Mathematics 205	3	2	1	Major	
Chemistry 105	3	2	1	Major	
Physics 107	3	2	1	Major	
Physics Lab. 111	1	2	1	Major	
Electrical Engr. 222	3	2	1	Major	
English 202	3	2	2	Major	
Mathematics 202	3	2	2	Major	
Chemistry 106	3	2	2	Major	
Chemistry Lab. 107	1	2	2	Major	
Dynamics 222	3	2	2	Major	
Electrical Engr. Lab. 201	1	2	2	Major	
Electrical Engr. II 282	3	2	2	Major	
Engr. Math 308	3	3	1	Major	
Stoichiometry 304	3	3	1	Major	
Phys. Chem. Lab 307	1	3	1	Major	
Fluid Mechanics 341	3	3	1	Major	
Organic Chem. 221	3	3	1	Major	
Elec. Cirucit Lab 202	1	3	1	Major	
Physical Chem. 305	3	3	1	Major	
Numerical Analysis 309	3	3	2	Major	
Physical Chem. Lab 308	1	3	2	Major	
Physical Chem. 306	3	3	2	Major	
Heat Transfer 351	3	3	2	Major	
Organic Chemistry 222	3	3	2	Major	
Organic Chem. Lab. 223	1	3	2	Major	

DEGREE PROGRAM FOR CHEMICAL ENGINEERING (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Unit Operation I 401	3	4	1	Major	
Thermodynamics 405	3	4	1	Major	
Quantitative Analysis 341	2	4	1	Major	
Quan. Analysis Lab 343	1	4	1	Major	
Materials Sci. 371	3	4	1	Major	
Technical Elective	3	4	1	Elective	4
Transport Phen. Lab 353	1	4	1	Major	
Unit Operation II 402	3	4	2	Major	
Unit Operation Lab 404	2	4	2	Major	
Thermodynamics 406	3	4	2	Major	
Strength of Materials 323	3	4	2	Major	
Technical Elective	3	4	2	Elective	4
Reactor Design 507	3	5	1	Major	
Petroleum Technology 509	3	5	1	Major	
Petroleum Tech. Lab 511	1	5	1	Major	
Instrumentation 513	4	5	1	Major	
Industrial Management 463	3	5	1	Major	
Plant Design 508	3	5	2	Major	
Chemical Processes 512	3	5	2	Major	
Chemical Proc. Lab 514	1	5	2	Major	
Special Project 599	3	5	2	Major	
Metallurgy 523	3	5	2	Major	

PLASTICS DIVISION

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Unit Operation I 401	3	4	1	Major	
Thermodynamics 405	3	4	1	Major	
Quantitative Analysis 341	2	4	1	Major	
Quan. Analysis Lab 343	1	4	1	Major	
Materials Sci. 371	3	4	1	Major	
Materials Sci. 431	3	4	1	Major	
Unit Operation II 402	3	4	2	Major	
Unit Operation Lab 404	2	4	2	Major	
Strength of Materials 323	3	4	2	Major	
Thermodynamics 406	3	4	2	Major	
Polymer Processing 532	3	4	2	Major	
Reactor Design 507	3	5	1	Major	
Instrumentation 513	4	5	1	Major	
Polymer Proc. Lab 533	1	5	1	Major	
Petroleum Tech. 509	3	5	1	Major	
Technical Elective	3	5	1	Elective	4

DEGREE PROGRAM FOR CHEMICAL ENGINEERING (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Plant Design 508	3	5	2	Major	
Plastic Technology 521	3	5	2	Major	
Engr. Prop. of Polymers	3	5	2	Major	
Plastic Tech. Lab 523	1	5	2	Major	
Technical Elective	3	5	2	Elective	4

DEGREE PROGRAM FOR CIVIL ENGINEERING

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
Mathematics 105	3	1	1	Major	
Physics 105	3	1	1	Major	
Engr. Drawing 211	1	1	1	Major	
Humanity	3	1	1	Major	
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Mathematics 106	3	1	2	Major	
Physics 106	3	1	2	Major	
Physics Lab 110	1	1	2	Major	
Statics 221	3	1	2	Major	
Engr. Drawing 212	1	1	2	Major	
English 201	3	2	1	Major	
Mathematics 201	3	2	1	Major	
Physics 107	3	2	1	Major	
Physics Lab 111	1	2	1	Major	
Mathematics 205	3	2	1	Major	
Elec. Engr. I 222	3	2	1	Major	
Chemistry 105	3	2	1	Major	
Tech. English 206	3	2	2	Major	
Mathematics 202	3	2	2	Major	
Chemistry 106	3	2	2	Major	
Chemistry Lab 107	1	2	2	Major	
Dynamics 222	3	2	2	Major	
Elec. Engr. II 282	3	2	2	Major	
Elec. Engr. Lab 201	1	2	2	Major	
Engr. Math 308	3	3	1	Major	
Fluid Mechanics 341	3	3	1	Major	
Strength of Materials 323	3	3	1	Major	
Engr. Geology 351	3	3	1	Major	
Materials 371	3	3	1	Major	
Hydraulics 331	3	3	2	Major	
Hydraulics Lab 302	1	3	2	Major	
Survey & Meas. 363	3	3	2	Major	
Num. Anal. & Computer Programming 309	3	3	2	Major	
Strength of Mat. Lab 301	1	3	2	Major	
Thermo. & Heat Trans.323	3	3	2	Major	
St. Analysis I 322	3	3	2	Major	

DEGREE PROGRAM FOR CIVIL ENGINEERING (continued)

Course	Units	Year	Sem-ester	Type	Identification of Optional or Elective Course
Field Surveying CE-362	1	3	Summer	Major	
Soil Mechanics 451	3	4	1	Major	
Soil Mech. Lab 403	1	4	1	Major	
St. Analysis II 421	3	4	1	Major	
Rein. Concrete 413	3	4	1	Major	
Water & Waste Water I 444	3	4	1	Major	
Hydrology 431	2	4	1	Major	
Trans. Engr. I 472	3	4	2	Major	
Soil Engr. 454	3	4	2	Major	
Met. Structures 414	3	4	2	Major	
Water & Waste Water II 445	3	4	2	Major	
Engr. Const. 482	2	4	2	Major	
Summer Training 490	1	4	Summer	Major	

TRANSPORTATION DIVISION

Course	Units	Year	Sem-ester	Type	Identification of Optional or Elective Course
Engr. Management 583	2	5	1	Major	
Engr. Economy 506	3	5	1	Major	
Trans. Engr. II 573	3	5	1	Major	
Pavement Design 551	3	5	1	Elective	5
Traffic Engineering 572	3	5	1	Elective	5
Dynamics of St. I 521	3	5	2	Major	
Technical Electives	9	5	2	Elective	6

STRUCTURAL DIVISION

Course	Units	Year	Sem-ester	Type	Identification of Optional or Elective Course
Engr. Management 583	2	5	1	Major	
Engr. Eco. 506	3	5	1	Major	
Trans. Engr. II 573	3	5	1	Major	
Design of Struc. 613	3	5	1	Elective	7
Rein. Concrete II 614	3	5	1	Elective	7
Dynamics of St. I 521	3	5	2	Major	
Technical Electives	9	5	2	Elective	6

DEGREE PROGRAM FOR CIVIL ENGINEERING (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
WATER RESOURCES DIVISION					
Engr. Management 583	2	5	1	Major	
Engr. Eco. 506	3	5	1	Major	
Trans. Engr. II 573	3	5	1	Major	
Water Resources Engr.633	3	5	1	Elective	8
Design of Hydraulic St. 631	3	5	1	Elective	8
Dynamics of St. I. 521	3	5	2	Major	
Technical Elective	9	5	2	Elective	6
GEOTECHNICAL DIVISION					
Engr. Management 583	2	5	1	Major	
Engr. Eco. 506	3	5	1	Major	
Trans. Engr. I 573	3	5	1	Major	
Rock Mechanics 650	3	5	1	Elective	9
Foundation Engr. 652	3	5	1	Elective	9
GENERAL OPTIONAL DIVISION					
Engr. Management 583	2	5	1	Major	
Engr. Eco. 506	3	5	1	Major	
Trans. Engr. II 573	3	5	1	Major	
Civil Engr. Proj. 591	3	5	1	Elective	10
Civil Engr. Proj. 593	3	5	1	Elective	10
Dynamics of St. I 521	3	5	2	Major	
Tech. Electives	9	5	2	Elective	6

DEGREE PROGRAM FOR MECHANICAL ENGINEERING

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
English 101	4	1	1	Common	
Persian 101	3	1	1	Common	
Mathematics 105	3	1	1	Major	
Physics 105	3	1	1	Major	
Humanities	3	1	1	Elective	1
Engr. Drawing 211	1	1	1	Major	
English 102	4	1	2	Common	
Persian 102	3	1	2	Common	
Mathematics 106	3	1	2	Major	
Physics 106	3	1	2	Major	
Physics Lab 110	1	1	2	Major	
Mech. Engr. 212	1	1	2	Major	
Civil Engr. 221	3	1	2	Major	
English 201	3	2	1	Major	
Mathematics 201	3	2	1	Major	
Physics 107	3	2	1	Major	
Physics Lab 111	1	2	1	Major	
Chemistry 105	3	2	1	Major	
Mathematics 205	3	2	1	Major	
Elec. Engr. 222	3	2	1	Major	
English 202	3	2	2	Major	
Mathematics 202	3	2	2	Major	
Chemistry 107 Lab	1	2	2	Major	
Chemistry 106	3	2	2	Major	
Civil Engr. 222	3	2	2	Major	
Elec. Engr. 201	1	2	2	Major	
Elec. Engr. 282	3	2	2	Major	
Engr. Math 308	3	3	1	Major	
Mech. Engr. 301	1	3	1	Major	
Civil Engr. 323	3	3	1	Major	
Civil Engr. 301 Lab	1	3	1	Major	
Mech. Engr. 313	1	3	1	Major	
Thermodynamics (ME) 321	3	3	1	Major	
Mechanical Engr. 341	3	3	1	Major	
Elec. Engr. 202	1	3	1	Major	
Math 309	3	3	2	Major	
Mech. Engr. 303	1	3	2	Major	
Mech. Engr. 361	3	3	2	Major	
Mech. Engr. 322	3	3	2	Major	
Mech. Engr. 314	1	3	2	Major	
Mech. Engr. 331	3	3	2	Major	
Mech. Engr. 302	1	3	2	Major	

DEGREE PROGRAM FOR MECHANICAL ENGINEERING (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Mech. Engr. 304	1	4	1	Major	
Mech. Engr. 442	3	4	1	Major	
Elec. Engr. 347	3	4	1	Major	
Mech. Engr. 481	4	4	1	Major	
Mech. Engr. 482	3	4	1	Major	
Materials Sci. 371	3	4	1	Major	
Mech. Engr. 405	1	4	2	Major	
Mech. Engr. 444	3	4	2	Major	
Mech. Engr. 463	3	4	2	Major	
Mech. Engr. 483	3	4	2	Major	
Mech. Engr. 484	2	4	2	Major	
Materials Sci. 522	3	4	2	Major	
Mech. Engr. 562	3	5	1	Major	
Mech. Engr. 592	2	5	1	Major	
Mech. Engr. 599	1	5	1	Major	
Technical Electives	7	5	1	Elective	11
Mech. Engr. 593	2	5	2	Major	
Mech. Engr. 587	3	5	2	Major	
Mech. Engr. 406	1	5	2	Major	
Technical Electives	6	5	2	Elective	11

DEGREE PROGRAM FOR ELECTRICAL ENGINEERING

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Math 105	3	1	1	Major	
Physics 105	3	1	1	Major	
English 101	3	1	1	Common	
Persian 101	3	1	1	Common	
Engr. Drawing 211	1	1	1	Major	
History of Sci. 101	3	1	1	Elective	1
Math 106	3	1	2	Major	
Physics 106	3	1	2	Major	
English 102	3	1	2	Common	
Persian 102	3	1	2	Common	
Statics 221	3	1	2	Major	
Engr. Drawing 212	1	1	2	Major	
Physical Lab 110	1	1	2	Major	
English 201	3	2	1	Major	
Math 201	3	2	1	Major	
Chemistry 105	3	2	1	Major	
Math 205	3	2	1	Major	
Elec. Engr. 222	3	2	1	Major	
Physics 107	3	2	1	Major	
Physics Lab 111	1	2	1	Major	
Technical Engr. 202	3	2	2	Major	
Math 202	3	2	2	Major	
Chemistry 106	3	2	2	Major	
Dynamics 222	3	2	2	Major	
Elec. Engr. 282	3	2	2	Major	
Chemistry Lab 107	1	2	2	Major	
EE Lab 201	1	2	2	Major	
Engr. Math 308	3	3	1	Major	
Electromag. Fields I 311	3	3	1	Major	
Network Theory I 321	3	3	1	Major	
Strength of Mat. 323	3	3	1	Major	
Elec. Meas. I 301	2	3	1	Major	
Physical Electronics I 331	3	3	1	Major	
Num. Anal. & Computer Programming 309	3	3	2	Major	
Electromag. Fields II 312	3	3	2	Major	
Network Theory II 322	3	3	2	Major	
Physical Electronics II 332	3	3	2	Major	
Material Sci. 371	3	3	2	Major	
Elec. Meas. II 302	2	3	2	Major	

DEGREE PROGRAM FOR ELECTRICAL ENGINEERING (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Automatic Control 471	4	4	1	Major	
Energy Conversion 481	4	4	1	Major	
Electronic Circuits I 441	4	4	1	Major	
Fluid Mechanics 341	3	4	1	Major	
Wave Transmission 411	3	4	2	Major	
Power Transmission 486	4	4	2	Major	
Elec. Circuits II 442	4	4	2	Major	
Thermo & Heat Trans. 323	3	4	2	Major	
Design Study 490	1	4	3	Major	
Summer Training 404	1	4	3	Major	
Electric Machines 581	3	5	1	Major	
Indust. Electronics 541	3	5	1	Major	
B.S. Project I 591	2	5	1	Major	
Advanced EE Lab I 501	1	5	1	Major	
Technical Electives EE-1	3	5	1	Elective	12
Power Systems 586	3	5	2	Major	
Advanced Automatic Control 571	3	5	2	Major	
B.S. Project II 592	2	5	2	Major	
Advanced EE Lab II 502	1	5	2	Major	
Technical Elective EE-1	3	5	2	Elective	12

POWER & MACHINES

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
Advanced Phys. Electronics 531	3	5	1	Major	
Indust. Electronics 541	3	5	1	Major	
B.S. Project I 591	2	5	1	Major	
Adv. EE Lab I 501	1	5	1	Major	
Technical Elective EE2		5	2	Elective	12
Adv. Automatic Control 571	3	5	2	Major	
Pulse & Digital Techniques 546	3	5	2	Major	
B.S. Project II 592	2	5	2	Major	
Adv. EE Lab II 502	1	5	2	Major	
Technical Elective EE2		5	2	Elective	12

DEGREE PROGRAM FOR ELECTRICAL ENGINEERING (continued)

Course	Units	Year	Semester	Type	Identification of Optional or Elective Course
COMMUNICATIONS DIVISION					
Adv. Phys. Electronics 531	3	5	1	Major	
Communication Theory 551	3	5	1	Major	
B.S. Project I 591	2	5	1	Major	
Advanced EE Labs I 501	1	5	1	Major	
Technical Elective EE3	3	5	1	Elective	12
Pulse & Digital Electronics 546	3	5	2	Major	
Radiation & Propagation 554	3	5	2	Major	
B.S. Project II 592	2	5	2	Major	
Advanced EE Lab II 502	1	5	2	Major	
Technical Elective EE3	3	5	2	Major	12

IDENTIFICATION OF OPTIONAL OR ELECTIVE COURSES FOR SCHOOL OF ENGINEERING

1 Minimum Production: 3 units. Also use courses in Education (201), History (101).

2 Minimum production: 14 units. Use courses from any of the following: Ch.E. 305, Ch.E. 306, Ch.E. 510, Ch.E. 520, C.E. 421, C.E. 306, C.E. 521, E.E. 471, M.E. 442, M.E. 451, M.E. 481, M.E. 524, M.E. 568, M.E. 587, M.S.E. 437, M.S.E. 505, M.S.E. 507, M.S.E. 508, M.S.E. 511, M.S.E. 520, M.S.E. 532, M.S.E. 533, M.S.E. 538, M.S.E. 539, M.S.E. 555, M.S.E. 558, M.S.E. 572, M.S.E. 583, M.S.E. 585.

3 Minimum production: 3 units. Also use courses in Soc. (201), Anthro. (203). See 1, above.

4 Minimum production: 6 units. Chose from the following: Transport Phenomena I 343, Transport Phenomena II 344, Nuclear Engr. 510, Plastic Chemistry 517, Iron & Steel Making 520, Plastic Machinery 572.

5 Minimum production: 6 units. For additonal electives see Transportation Group in 6, below.

6 Minimum production: 0 units. Choose 9 units from 5, 7, 8, 9, & 10. For maximum production, choose from following: Pavement Design 551, Traffic Engr. 572, Design of Structures 613, Reinforced Conrete II 614, Water Resources Engr. 633, Design of Hydraulic St. 631, Ground Water 632, Rock Mechanics 650, Foundation Engr. 652, Earth Structure 653, Civil Engineering Project 591, Civil Engineering Project 593.

7 Minimum production: 6 units. For additional electives see Structural Group: Design of Structures 613, Reinforced Concrete II 614, Dynamics of St. II 625, Structural Analysis III 626.

8 Minimum production: 6 units. For additional electives see Water Resources Group: Water Resources Engr. 633, Design of Hydraulic St. 631, Ground Water 632, Design of Water & Waste Water Treatment Plants 641, Environmental Health 643.

9 Minimum production: 6 units. For additional electives see Geotechnical Group: Rock Mechanics 650, Foundation Engineering 652, Earth Structure 653, Geotechnical Mechanics 654, Dynamics of Foundation 655, Earth Dams 658.

10 Minimum production: 6 units. For additional electives see General Optional Group: Civil Engineering Project 591, Civil Engineering Project 593, Urban Planning 561, Eng. Analysis 605, Advanced Strength of Mat. 623, Continuum Mechanics 627, System Engineering 680.

11 Minimum production: 13 units, if M.E. is the only degree program produced. Substitute courses from any engineering or science program.

12 Minimum production: 0 units. Choose from courses produced for other group specialties, i.e., Group II, and Group III, Group II, Courses in Group I and Group III, etc.

APPENDIX D
COMPUTER PROGRAM LISTING

COMPUTER PROGRAM LISTING

```
$WATFIV
      DATA BLANK/'    '/,TEV/'T   '/,BAL/'L   '/,SEN/'S   '/,PRJ/'P   '/
      DATA RPN/'N   '/
      INTEGER IS(20,20),A(2000,8),B(10000,6),C(2000),KL(20,20),BI(200,6)
      INTEGER BB(1000,6),SUM(3),S(20,20),D(20,20),SUMI(3),GFR(3),CNR(3)
      DIMENSION G(3),H(3),ID(20,20),CI(630),GI(3),HI(3),HA(3),HB(3)
      DIMENSION GA(3),HC(3),HD(3),HE(3),HF(3),F(3),E(3),P(1000),V(630)
      DIMENSION LF(3),W(630)
      DATA NPR/'N   '/
      READ10,((A(I,J),J=1,8),I=1,630)
   10 FORMAT(24I3)
      READ10,((B(K,L),L=1,6),K=1,1000)
      READ10,((BB(KK,LL),LL=1,6),KK=1,400)
      READ10,((BI(K,L),L=1,6),K=1,200)
      READ2,((IS(IA,JA),S(IA,JA),ID(IA,JA),D(IA,JA),JA=1,20),IA=1,20)
    2 FORMAT(10(I4,I1,I1,I2))
      READ4,IN,IR,IT,NA,N,LF,RF,RM,FL,FP,SF,DF,CN,RDF,RDM,RP,FC
    4 FORMAT(3(I5),3(I2),10(F5.1),F5.2)
      IA=0
  111  IA=IA+1
      PRINT61,IA
   61 FORMAT('1','YEAR=',I2)
      JC=0
      DO 8 I=1,630
      C(I)=0
      P(I)=0
      CI(I)=0
      V(I)=BLANK
      W(I)=BLANK
    8 A(I,7)=0
      DO 99 JA=1,20
      DO 88 K=1,400
   88 BB(K,6)=0
      DO 87 I=1,630
   87 A(I,8)=0
      IB=0
   42 IF(IB.EQ.IA)GO TO 99
      IB=IB+1
      IF(IS(IB,JA).EQ.0)GO TO 42
      JC=JC+1
      KL(IB,JC)=IS(IB,JA)
      K=0
   22 K=K+1
      IF(K.EQ.1001)GO TO 99
      IF(B(K,2).NE.0)GO TO 22
      IF(B(K,1).NE.IS(IB,JA))GO TO 22
      K=K+3
   32 K=K+1
   30 IF(B(K,2).EQ.0)GO TO 99
      KA=B(K,3)/10
      IF(IA.GT.KA)GO TO 13
      NT=IN
      GO TO 15
   13 NT=IT
   15 Y=ID(IB,JA)*10
      IF(B(K,3).GT.Y)GO TO 81
      B(K,5)=NT/NA
      GO TO 82
   81 B(K,5)=NT/(NA*D(IB,JA))
   82 CONTINUE
```

COMPUTER PROGRAM LISTING (cont)

```
      IF(B(K,4).EQ.3)GO TO 80
      IF(B(K,4).EQ.5)GO TO 90
C SEARCH IN THE CATALOG
      I=0
   40 IF(I.EQ.630)GO TO 32
      I=I+1
      IF(A(I,1).NE.B(K,1))GO TO 40
      IF(A(I,2).NE.B(K,2))GO TO 40
      IF(A(I,8).GE.D(IB,JA))GO TO 33
      C(I)=B(K,3)
      A(I,7)=A(I,7)+B(K,5)
      A(I,8)=A(I,8)+(B(K,5)+3)*NA*D(IB,JA)/NT
      IF(B(K,4)-4)32,11,32
   11 CI(I)=A(I,7)*A(I,3)/FP
      GO TO 32
   33 B(K,6)=1
      GO TO 32
C SEARCH FOR ELECTIVE
   80 KK=0
   70 KK=KK+1
      IF(B(K,2).NE.BB(KK,2))GO TO 70
      NUM=0
      KB=KK+3
      NU=B(K,1)-BB(KK,1)
   60 KB=KB+1
      IF(KB.GE.401)GO TO 71
      IF(BB(KB,2).GE.900)GO TO 71
      DO 50 I=1,630
       IF(BB(KB,1).NE.A(I,1))GO TO 50
       IF(BB(KB,2).NE.A(I,2))GO TO 50
      IF(C(I).EQ.0)GO TO 60
      IF(A(I,8).GE.D(IB,JA))GO TO 60
      NUM=A(I,3)+NUM
      IF(NUM.GT.NU)GO TO 32
      A(I,8)=A(I,8)+(B(K,5)+3)*NA*D(IB,JA)/NT
      A(I,7)=A(I,7)+B(K,5)
      GO TO 60
   50 CONTINUE
   71 IF(NUM.GT.NU)GO TO 32
      KB=KK+3
   72 KB=KB+1
      IF(KB.GE.401)GO TO 32
      DO 51 I=1,630
      IF(BB(KB,1).NE.A(I,1))GO TO 51
      IF(BB(KB,2).NE.A(I,2))GO TO 51
      IF(C(I).NE.0)GO TO 72
      IF(A(I,8).GE.D(IB,JA))GO TO 72
      A(I,7)=A(I,7)+B(K,5)
      C(I)=B(K,3)
      NUM=NUM+A(I,3)
      A(I,8)=A(I,8)+(B(K,5)+3)*NA*D(IB,JA)/NT
      IF(NUM-NU)72,32,32
   51 CONTINUE
      GO TO 32
   90 KK=0
   91 KK=KK+1
      IF(KK.GE.201)GO TO 32
      IF(B(K,2).NE.BI(KK,2))GO TO 91
      NUM=0
      KB=KK+3
```

COMPUTER PROGRAM LISTING (cont)

```
      NU=B(K.1)-BI(KK.1)
   92 KB=KB+1
      IF(KB.GE.201)GO TO E3
      IF(BI(KB.2).GE.800)GO TO E3
      DO 84 I=1.630
      IF(BI(KB.1).NE.A(I.1))GO TC 84
      IF(BI(KB.2).GT.A(I.2))GO TC E4
      IF(C(I).EQ.0)GO TO E4
      NUM=NUM+A(I.3)
      IF(NUM.GE.NU)GO TO 32
      IF(A(I.8).GE.D(IB.JA))GO TC E4
      A(I.8)=A(I.8)+(B(K.5)+3)*NA*C(IB.JA)/NT
      A(I.7)=A(I.7)+B(K.5)
   84 CONTINUE
      GC TC 92
   83 IF(NUM.GE.NU)GO TO 32
      KB=KK+3
   85 KB=KB+1
      IF(KB.GE.201)GO TO 32
      DO 86 I=1.630
      IF(BI(KB.1).NE.A(I.1))GO TO E6
      IF(DI(KB.2).GT.A(I.2))GO TC 86
      IF(C(I).NE.0)GO TO E6
      IF(A(I.8).GE.D(IB.JA))GO TC 86
      A(I.7)=A(I.7)+B(K.5)
      C(I)=B(K.3)
      NUM=NUM+A(I.3)
      A(I.8)=A(I.8)+(B(K.5)+3)*NA*C(IB.JA)/NT
      IF(NUM.GE.NU)GO TO 32
   86 CONTINUE
      IF(BI(KB.2).LT.800)GC TO 85
      GO TO 32
   95 CONTINUE
      IF(IB.NE.IA)GO TO 1
      PRINT64.(KL(IB.JC).JD=1.JC)
   64 FORMAT(20(I6))
    1 IK=IA*10                                     ETVST   NTVST   STAFF  MENT
      PRINT66
   66 FORMAT(' S LECV LECH   ETVHR  NETVHR
     *CP  LABFAC  SEMFAC  PRCFACTOTALFAC ONRH, LRF,OFRH')
      DO 105 K=1.3
      SUM(K)=0
      SUMI(K)=0
      F(K)=0
      G(K)=0
      GI(K)=0
      H(K)=0
      HI(K)=0
      HA(K)=0
      HB(K)=0
      HC(K)=0
      HD(K)=0
      GA(K)=0
      LF(K)=0
      OFR(K)=0
      ONR(K)=0
      DC 100 I=1.630
      IF(C(I).NE.C)GO TO 130
      V(I)=RPN
      GO TO 100
```

COMPUTER PROGRAM LISTING (cont)

```
  130 LK=C(I)/10
      L=C(I)-10*LK
      IF(L.NE.K)GO TO 100
       A(I.8)=0
      MM=A(I.7)*A(I.5)/LF
      AN=MM/FL
      IF(A(I.5).EQ.0)GO TO 12
      A(I.8)=A(I.7)*A(I.5)/12
      V(I)=BAL
      LR(K)=LR(K)+A(I.8)
   12 HA(K)=HA(K)+AN
      HC(K)=HC(K)+A(I.6)/SF
      HD(K)=HD(K)+CI(I)
      IF(CI(I).EQ.0)GO TO 9
      V(I)=PRJ
    9 IF(A(I.6).EQ.0)GO TO 7
      V(I)=SEM
    7 IF(C(I).GT.IK)GO TO 120
      IF(A(I.7).LE.500)GO TO 120
C CALCULATION OF ETV PRODUCTION
      SUM(K)=SUM(K)+A(I.4)
      A(I.8)=A(I.4)+A(I.6)+A(I.5)*A(I.7)/12
      AM=A(I.7)*A(I.4)/(RM*(40.0-A(I.4)))
      NM=AM
       X=(AM-NM)*(40.0-A(I.4))/40.0+A(I.4)/40.0
      AM=NM+X
      GA(K)=GA(K)+AM
      HE(K)=HE(K)+A(I.4)/RF
      CI(I)=A(I.4)/RF+CI(I)+A(I.6)/SF
      P(I)=AM+AN
      IF(A(I.4).EQ.0.AND.A(I.6).EQ.0)GO TO 100
      W(I)=TEV
      OFR(K)=OFR(K)+A(I.4)*A(I.7)/120
      GO TO 100
C CALCULATION OFNTV PRODUCTION
  120 SUMI(K)=SUMI(K)+A(I.4)
      X=A(I.4)/RF
      IF(A(I.7).LT.CN)GO TO 17
      X=X+X*FC
      Z=A(I.7)/(CN*2)
      NZ=2*Z
      Z=2*Z
      IF(Z.EQ.NZ)GO TO 16
      Z=(NZ+1)/2
   16 X=X*Z
   17 HI(K)=HI(K)+X
      GI(K)=GI(K)+A(I.7)*A(I.4)/(RM*CN)
      CI(I)=X+CI(I)+A(I.6)/SF
      P(I)=AN+A(I.7)*A(I.4)/(RM*CN)
      IF(A(I.8).NE.0)GO TO 135
      IF(A(I.6).EQ.0)GO TO 135
      A(I.8)=A(I.6)*A(I.7)/200
  135 IF(A(I.4).EQ.0)GO TO 100
      IF(A(I.7).GE.40)GO TO 140
      A(I.8)=A(I.8)+A(I.4)
      GO TO 150
  140 A(I.8)=A(I.7)*A(I.4)/40
      KX=A(I.8)*40+10
      IF(KX.GT.A(I.7))GO TO 150
      A(I.8)=A(I.8)+1
```

COMPUTER PROGRAM LISTING (cont)

```
      150 ONR(K)=ONR(K)+A(I.8)
      100 CONTINUE
          HE(K)=SUM(K)*9.5
          HF(K)=HE(K)-F(K)
          F(K)=HE(K)
          G(K)=GI(K)+GA(K)
          H(K)=HI(K)+HB(K)
          E(K)=H(K)+G(K)+HA(K)+HC(K)+HD(K)
          PRINT65.K.SUM(K).SUMI(K).HE(K).HF(K).HB(K).HI(K).H(K).G(K).HA(K).H
         *C(K).HD(K).E(K).ONR(K).LR(K).OFR(K)
       65 FORMAT(I2.2I5.10F8.1.3I5)
      105 CONTINUE
          PRINT76
       76 FORMAT(4(' COURSEOKSTUD.  FAC.  MENT  ROCH '))
          PRINT77.(A(I.1).A(I.2).V(I).W(I).A(I.7).CI(I).P(I).A(I.8).I=1.630)
       77 FORMAT(4(1X.2I3.2A1,I5,2F6.1,I4,3X))
          PRINT165
      165 FORMAT(' COURSE YSUNIT  STUD')
          DO 160 I=1.630
          IF(W(I).NE.TEV)GO TO 160
          PRINT170.A(I.1).A(I.2).C(I).A(I.4).A(I.7)
      170 FORMAT(1X,3I3,I4,I6)
      160 CONTINUE
          DO 101  JA=1.20
          NI=IA+(IT-IN)/IR+S(IA.JA)-5
          IF(NI.LE.N)GO TO 101
          N=NI
      101 CONTINUE
      110 IF(IA.LT.N)GO TO 111
          STOP
          END

    $DATA
```